The Mississippi River

TESTIMONY

OF

GENERAL COMSTOCK

AND

Engineers Kingman, Leach, Suter, Flad, Richardson, Dabney, Thompson, Starling, and Others,

GIVEN BEFORE THE

COMMERCE COMMITTEE, U. S. SENATE,

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HEARINGS

BEFORE THE

COMMITTEE ON COMMERCE,

UNITED STATES SENATE,

IN RELATION TO THE

IMPROVEMENT OF THE MISSISSIPPI RIVER.

TESTIMONY OF GEN. C. B. COMSTOCK.

Gen. CYRUS B. COMSTOCK, President of the Mississippi River Commission, appeared before the Committee.

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Gen. COMSTOCK. Outlets have often been proposed as a method of reducing flood heights on the Mississippi. The immediate results of flood heights are so evident and so beneficial when a large crevasse is formed, the good results of an opening far larger than ever occurs naturally seem so immediate and apparent that it is not strange that many persons look on them as the true remedy for great floods.

In a letter of February 1, 1890, to the Chief of Engineers, I considered the effects of making an outlet a mile wide and to a depth of 10 feet below low water from the Mississippi River into Lake Borgne, and need not repeat the discussion here. In it I assumed what is well known to all persons familiar with hydraulics, namely, that a sedimentary river flowing in its own alluvion only acquires a stable regimen when it has taken a slope suitable to its varying discharges and to the material through which it flows; and as a

rule that these slopes diminish as the size of the river increases and increase as the size of the river decreases. It may be well to give some examples of this general fact.

The South Pass carried in 1875 about one-fourth of the water that the Southwest Pass did. Its slope from the Head of the Passes to its original bar was about one-third greater than that of the Southwest Pass.

The observed discharges of the Atchafalaya in 1882 were from one-seventh to one-tenth of those of the Mississippi. Its average slope to the Gulf is double that of the Mississippi.

The Sulina Pass in the delta of the Danube carries two-twenty-sevenths of the total river flow, while the St. George Pass carries eight-twenty-sevenths. The slope of the Sulina is one-half greater than that of the St. George Pass.

These examples are sufficient to illustrate the general rule already stated, that sedimentary rivers flowing in their own alluvion take larger slopes the smaller they are. Hence, if at Lake Borgne or elsewhere in its delta the Mississippi were divided into two rivers, since each would be smaller than the present river, the two new rivers would go to work to obtain the new and steeper slopes suited to dimensions smaller than those of the original river, and hence would build up their beds. This process would only cease when the steeper slopes needed by each were obtained. Since both rivers would then have one end at the Gulf, and have steeper slopes up to their point of divergence than the main river now has, the flood surface of the rivers at that point would be higher than now.

There have been cases where the experiment of dividing a river in two has been tried by nature or by man. About A. D. 1438 the Adige broke its levees and poured its waters south into the Castagnoro and Canale Bianco, which then formed a drainage stream parallel to the Po. In 1545 the break had so increased that two-thirds of the low-water flow of the Adige and three-fourths of the high-water flow went through it. A low dam was built across the Castagnoro to check the flow into it, and both rivers raised their beds. In 1678 a new dam was built, as the old one was then buried in the deposit. The bed still rose. In 1791 a masonry dam 39 feet high, with many archways through it to allow floods to pass, was built across the Castagnoro. The bed continued to rise, and the floods on the Adige were so high that in 1838 the Castagnoro was permanently closed. In the six years following the closure, the floods in the Adige fell, and the more markedly the nearer the point considered was to the Castagnoro.

Thus far only outlets have been considered which are permanent rivers. For such outlets the effect in finally raising the flood surface of the main river will be the greater as the flow of the outlet is more nearly equal to the remaining flow in the main river. If the outlet is small, its effect on the main river will be small.

Places where there is no escape except at high stages are sometimes called outlets. For many years prior to the recent closing of levee gaps along the Mississippi below Red River, and of the gaps

which permitted water to escape from the vicinity of Turnbulls Island into the Atchafalaya Basin, the maximum flood flow past New Orleans was but about 1,100,000 cubic feet per second. This flow is ample for all navigation purposes, and no practical gain to navigation will result from increasing it. In 1882 it was estimated that about 2,200,000 cubic feet per second passed the latitude of Red River mouth. It has been proposed to allow only 200,000 cubic feet per second to go down the Atchafalaya, leaving 1,900,000 or 2,000,000 cubic feet per second to go down the main river.

In my judgment, until the heights of levees below Red River are largely increased, there should be left a free opportunity for the escape overland of 400,000 cubic feet per second from the vicinity of Turnbulls Island into the Atchafalaya Basin, in such floods as those of 1882, in addition to the 200,000 cubic feet per second which is to go down the Atchafalaya. If such an escape, existing only at high water, be called an outlet, then I think it necessary, at least for the present. It will do no harm to navigation, which was good enough for many years before the escape into the Atchafalaya Basin was reduced. On the other hand, to try to force in a great flood 1,900,000 cubic feet per second past New Orleans, with levees at present heights, is sure to renew the disasters to levees at or below Red River which have occurred this year. The injury resulting from many breaks below Red River is so much greater than that resulting from the escape into the Atchafalaya Basin from the vicinity of Turnbull's Island, that the lesser interest should yield to the greater until it is possible to protect both.

It may be concluded, then, that the reduction, by any large amount, of the flow of the Mississippi at Lake Borgne below what it has been for many years, will be ultimately followed by a rise in the flood heights at that place and a shoaling of the river below and at its mouth.

Also that until levees below Red River are much higher than they are now, about 600,000 feet per second in the greatest floods should be allowed to go into the Atchafalaya Basin, thus relieving the river below.

The opinion that the head of the Atchafalaya Basin should not be closed by levees was urged by me in the Annual Report of the Mississippi River Commission for 1884.

There is one other question, and that is, that leveed rivers raise their beds higher and higher as the levees are raised. That is a very essential question in levees, as long as are those on the Mississippi, and I have some memoranda as to them which I can read to the committee.

The CHAIRMAN. The statement has been made that the bed of the Mississippi River has risen some seven or eight feet.

General COMSTOCK. I have heard that. I have examined that question also. I have prepared a statement as to that question.

The statement is often made that leveed rivers raise their beds higher and higher as levees are raised, and hence that levees will give no permanent relief against overflow. These statements are

usually made fron theoretical opinions and without a thorough knowledge of the theoretical side of the subject, and probably without any knowledge of the facts of experience, which alone can lead to conclusions entirely safe. The river Po has long been leveed, and it is often stated that its bed has risen largely in consequence of levees. The following data will show how unfounded is the statement that the bed has risen by amounts that are of much importance:

At the revival of civilization the levees on the Po were complete and continuous from Cremona to the mouth of the Oglio, 49 kilometers, or 58.4 miles. About A. D. 1300 they were carried farther down the river, and in the succeeding centuries to near its mouth. In the present century levees have been systematized as to height. Four hundred kilometers, or 248½ miles, were below the flood of 1872. At the end of 1877 it was expected to reduce this to about 30 kilometers, or 18 miles. (Cenni monografici sull' idraulica fluviale in Italia. *Roma*, 1878.)

Zendrini, in 1720, observed an extreme low water at Ponte Lagoscuro, only .36 foot less than that of 1817; and at the dam of Governolo, near the mouth of the Mincio, the river was 1.3 feet lower than a stage of water of 1609, declared by Bardazzoli to be marvelous (Lombardini, Notizii).

The Cenni Monografici gives the following:

Pontelagoscuro.

Years.	Mean lowest water.	Mean highest water.	Maximum high water.	Minimum low water.
	M. Ft.	*M. Ft.*	*M. Ft.*	*M. Ft.*
1807–1825	3.28=10.4	7.42=24.3	8.62=28.3	0.38=1.3
1826–1850	3.26=10.3	7.38=24.2	8.96=29.4	0.72=2.3
1851–1875	3.19=10.1	7.39=24.2	9.32=30.5	0.62=2.0

The above gauge-readings, which have been only kept since 1807, show that there has been no important rise of the bed of the river (since that could not rise without raising the low-water surface) at Pontelagoscuro in the sixty-eight years covered; and in connection with Zendrini's observations, show that there has been no probable rise of any importance since 1720, although the raising of levees has been going on during this period. Lombardini (Dei Congiamenti del Po, 1852, p. 17) examines this question for points above Pontelagoscuro, which itself is 92 kilometers (57 miles) from the mouth of the Po. He concludes that at Ostiglia, which is 183 kilometers (114 miles) above the mouth, the bed appears to have risen a few decimeters (decimeter=3.9 inches) in a century, while at Governolo, 15 kilometers (9⅓ miles) above, it appears to have been stationary for four centuries.

In *Il grande estuario Adriatico*, 1868, *Appendix D*, he gives the following table of heights of low waters above the lowest water known, which was in May, 1817:

Means of observed low waters, in meters.

Years.	Ostiglia.	Sermide.	Quatrelle.	Pontelagoscuro.
	M.	*M.*	*M.*	*M.*
1817–1850	0.55	0.54	0.47	0.49
1851–1867	0.44	0.77	0.84	0.55

Comparing the means from 1817 to 1850 with those from 1851 to 1867, it will be seen that a small rise in low-water heights is indicated; but the observations at several stations in the first period were few, hence the results are uncertain.

The flood heights have, however, steadily risen. The following greatest floods are recorded:

	M.	*Ft.*	
1705–1756	1.82	= 6.0	in the year 1755
1757–1796	2.15	= 7.1	in the year 1777
1797–1836	2.68	= 8.8	in the year 1833
1837–1877	3.22	=10.6	in the year 1872

From this table it appears that the highest floods have increased in height since 1705, by 1.4 meters (4.6 feet). The rise in flood heights on the Po has not been confined to the single point Pontelagoscuro, but has extended far above.

Gallizia (Giornale del genio civile, February, 1878) examines this question and gives the following results. The miles given are reckoned from the mouth of the river.

At Becca (394 kilometers, or 245 miles), within the century, there is a progressive rise of 1.53 meters (5 ft.) from 1801 to 1857; at Corossa (337 kilometers, or 209 miles) the flood of 1801 read 6.35 meters, and their heights rose gradually to 7.95 meters in 1872, or to 7.45 meters if allowance is made for a change of bed at this place. At Casal Maggivre (223 kilometers, or 145 miles) from 5.60 meters in 1801, the floods rose gradually to 6.07 meters in 1868, a rise of 0.47 meters, or 1.5 feet. At Ostigilia (149 kilometers, or 93 miles), from 6.80 meters in 1801, and 7.50 meters in 1812, to 8.56 meters, although the river was not entirely confined. At Pontelagoscuro (92 kilometers, or 57 miles), from 2.19 meters, *sopra guardia*, in 1801, to 3.32 meters in 1872, the river not being entirely confined in this last year—a rise of 1.13 meters (3.7 feet), so that on the average there has certainly been a rise of more than a meter (3.28 feet) in the last seventy-five years along the whole course of the leveed river, excluding the Parma Cremona front, where the levees are far apart, and the rise is about one-half as much.

Cenni Monografiri sull'idranlica, p. 59, attributes the increased heights of the great flood of 1839 to "the more perfect leveeing of the Po and its tributaries, preventing the lateral escape of the waters, and sending in a canal to the sea that which previously flowed over the country."

Lombardini (Ilgrande estuario Adriatico, p. 96) says the increased floods "arise in part from levees which hinder their spreading out, and also from the deforesting of mountain slopes."

Gallizia (loc. cit.) attributes increase of floods to deforesting, to the interest each one has to get rid of injurious water, without consideration for those below him, to the leveeing of upper parts of rivers

and their tributaries, and to the extension of the river mouth into the sea.

To sum up in reference to the Po, it may be said that during the present century the levees on the Po have been systematized and raised to follow an increase in flood height that in seventy-five years amounted to about three feet along the leveed portion of the river; and that there is some evidence of a small rise in the extreme low-water surface of the river, which may be caused by a rise of the bed. It should be noticed however, that the rise in the bed (if it really exists) amounts to only two-hundredths of a foot a year, and that the annual cost of raising levees to keep up with it would be but a small part of the annual cost of a complete system of levees.

As to the rise in the flood level as the waters are more and more thoroughly confined, it may be said that this was a necessary result of confinement; that the same thing occurs on the Mississippi, and that it will cease when the levees have been built high enough to contain the greatest floods.

On the Po, thus far, during the last seventy-five years the effect of the confinement of waters in raising the flood level has far exceeded any tendency that confinement may have had to reduce flood heights by scouring the bed.

Senator WASHBURN. Are the conditions the same in the Valley of the Po as in the Mississippi Valley?

General COMSTOCK. Yes, sir, essentially the same; an alluvial stream.

Senator CULLOM. So that your conclusion is that the bed of the river has not risen?

General COMSTOCK. Not to any considerable amount; not to exceed 6 or 8 inches.

Senator CULLOM. For how long a period?

General COMSTOCK. From seventy-five to one hundred years.

Senator CULLOM. Oh, that is the Po. What is the fact with reference to the Mississippi River?

General COMSTOCK. Our records of low water run back only twenty-five or thirty years. Our records do not go back far enough to draw an intelligent conclusion. You want a period of from seventy-five to one hundred years to say positively whether any changes have occurred.

The Rhine is also a river which, below Dusseldorf, has long been leveed, and if levees raise the bed of a river, here they should have produced their full effects, as they are rarely broken.

The following table from Fijnje (Beschonwingen over eenige rivieren, erste gedeelte, bijlage A, p. 185) gives (in meters) the height of the lowest water which occurred in each ten years from 1772 to 1880, above the Amsterdam zero, for Cologne and Emmerich:

Years.	Cologne.	Emmerich.	Years.	Cologne.	Emmerich.
1772–1780	36.82	11.29	1831–1840	36.30	10.88
1781–1790	36.14	11.26	1841–1850	36.35	10.81
1791–1800	36.36	11.24	1851–1860	36.06	10.16
1801–1810	36.56	11.11	1861–1870	36.03	9.92
1811–1820	36.30	11.03	1871–1880	36.28	10.21
1821–1830	36.30	10.64			

It will be seen that the law-water surface appears to have fallen in the last hundred years at Emmerich, and possibly at Cologne.

Hagan (Wasserstande in den Preussischen Stromen, p. 12) carefully examines the gauge readings at Cologne, from 1846 to 1879, and at Dusseldorf, from 1800 to 1879, to detect changes in high and low water heights. Treating the gauge reading by the method of least squares, he found the most probable annual change in the water heights. At Dusseldorf he found that, with great probability, there was an annual sinking of the maximum high water in each year amounting to 0.3 inch; that the mean stage did not change, and that the annual lowest waters showed, with some probability, an annual rise of one-twelfth of an inch.

For Cologne he found that, with great probability, the high waters had sunk, and the lowest waters had risen by about the same amounts as at Dusseldorf. A rise of one-twelfth of an inch a year, or eight inches in a hundred years, is so small as not to be an important matter in a system of levees; and if the hundred years of the table above are taken, this rise disappears.

It has often been asserted that the bed of the Hoang Ho, or Yellow River of China, has risen above the surrounding country where it is leveed. The error, originally due to Abbe Huc, has been repeated by English writers on China. The following extract from a letter to me by Gen. J. H. Wilson (a very competent authority) gives reliable information on the subject:

WILMINGTON, DEL., *May* 6, 1890.

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In reply I hasten to say that I crossed the Yellow River on the 7th of January, 1866, near the city of Kai-fong-fu, in the province of Honan, and visited the site of the great break of 1853, about thirty miles below Kai-fong-fu; also traversed its embankments or levees on both banks of the river, visiting and measuring them at various points between Kai-fong-fu and Chinau-fu, in the province of Shan-Toong, taking observations, notes, and measurements, and having specially in view the repair and maintenance of the embankments, their present condition, and the effects produced by them. I had no instruments, however, except a hand-level, sextant, and tape-line, and could take no accurate levels across embankments, bed of the stream, fore-shores, and adjacent plains, but the conclusion I came to in regard to the influence of the levees upon the bed of the river was that they had nowhere filled it to a higher level than the adjacent country. I had heard Father Huc's narrative on that point, and I visited the plan at which the river had left its old channel in 1853, leading to the sea south of the peninsula of Shan Toong, and made itself an absolutely new one to the Gulf of Pe Chi Li, north of that peninsula. Between this place—known on the maps of Asia (Kirke Johnson's is the best) as Lung mum Ku—and Kai-fong-fu, the embankment was very large, but it was near the latter place that the great break occurred two years ago. This was closed after incredible efforts and great expense and this river forced to resume its old channel, where it is now emptying itself, according to my

advices of a few months ago, and where it will most probably continue to empty itself till it can find a shorter line and steeper declivity to tide-level.

By referring to my little book on China (Appleton & Co.) you will get other details.

In conclusion, I do not hesitate to say that I can not but believe that Abbe Huc was entirely mistaken in regard to the silting up of the channel, and that an exhaustive survey would prove beyond a doubt that no such silting as to raise any part of the bed above the adjacent country has ever taken place.

Yours, very truly, JAMES H. WILSON.

The question of the rise of bed of the Mississippi will now be considered. Unfortunately, it has not been studied as thoroughly as the Rhine and Po, and its gauge-records go back but a few decades.

Levee building has gone on most rapidly since 1880, and as the river was very low in December and January, 1887–'88, and again in October and November, 1889, if there has been any important rise in the river-bed resulting therefrom, it should show itself in a corresponding rise in the extreme low-water surface.

Several places will be considered, selecting those where our gauge-records cover as many years as possible.

(1) *Cairo.*—The lowest water record extends back to 1859, with breaks, but is continuous since 1871. January 1, 1888, the gauge read 1.8 feet, and October 2, 1889, it read 2.7 feet. From November 10, 1859, to these dates, the record gives but three years when the water was as low as in 1888 and 1889. These years were:

	Feet.
December 26, 1871; Cairo gauge	—1.0
December 6, 1872; Cairo gauge	1.0
January 1, 1877; Cairo gauge	1.0

These gauge readings are lower than those of 1888 and 1889, but the period since 1880 is entirely too short to conclude that in it there was a year in which the discharge reached its lowest value, thus giving extreme low water. The greater low-water heights in 1888 and 1889 may be simply due to there being more water flowing in the river at those times than in 1871. If in seventeen years following 1888 there are no gauge readings as low as those of 1871, 1872, and 1877, it will in some degree indicate but not prove that the bed has risen. At present the data do not extend over a period long enough to draw any reliable conclusions.

(2) *Memphis.*—This gauge read:

	Feet.
November 20, 1887	1.20
January 4, 1888	0.80
October 26, 1889	1.90

The records of low water before these dates extend back to 1848, and are continuous back to 1871. The records back to 1848 give but three dates when the water was lower than on January 4, 1888, namely 0.80 feet. These dates are:

December 29, 1871	—0.92
December 22, 1872	—0.95
January 2, 1877	+0.75

Here again the extremely low waters of 1871 and 1872 show themselves, and they are lower than any since 1880. But as was said with reference to Cairo, the period since 1880 is entirely too short to enable us to assume that in it there has been a year of minimum flow, or, what amounts to the same thing, that there will not in a few years occur a stage as low as that of December 29, 1871.

(3) *Helena.*—The low-water record is continuous, excepting 1878 and 1879, back to 1871. The gauge reads:

	Feet.
December 29, 1871	1.15
December 26, 1872	0.00

The record afterwards gives no waters as low as these till 1887. The gauge reads:

	Feet.
November 20, 1887	1.20
January 4, 1888	0.80

Comparison of the two periods gives a difference too small to establish a rise of low-water level.

(4) *Lake Providence.*—The low-water record extends back to 1872, and the lowest waters are:

	Feet.
December 29, 1872	—3.85
October 16, 1879	0.55

Since 1880 the two lowest waters are:

	Feet.
November 22, 1887	1.52
October 31, 1889	2.80

There seems to have been a great depresssion of low water in this part of the river about 1872. The Terrapin Neck cut-off, shortening the river about 16 miles, occurred in 1866 and may have been a partial cause. The gauge readings given indicate a rise in the water surface and probably of the bed at Lake Providence since 1872.

(5) *Vicksburg.*—Excepting 1878 and 1879, the low-water record is continuous back to 1872. The gauge reads:

December 30, 1872	—1.30

From this date to 1886 the lowest record is:

January 6, 1887	2.25

Since 1880 we have:

	Feet
November 16, 1886	0.00
November 24, 1887	3.91
January 7, 1888	1.32
October 29, 1889	0.80

Here the gauge records indicate a fall in the low-water surface and perhaps a fall in the bed. The question is complicated by the Terrapin Neck cut-off of 1866, the Vicksburg cut-off of 1876, and the Davis Island cut-off of 1867.

From 1872 to 1881 the low-water fall in the surface of the river between Lake Providence and Vicksburg varied between 21.0 feet and 22.9 feet; in 1883 it was 24.9; in 1886, 26.2; in 1887, 29.0; in 1888, 26.7; and in 1889, 27.2 feet. The change of fall from 22.6 feet in 1881 to 29.0 feet in 1887, amounting to 6.4 feet, is very great. About two-thirds appear to be due to a sinking of the low-water plane at Vicksburg, and the rest to a rise in the low-water plane at Lake Providence. The low-water slope from Lake Providence to Vicksburg was in 1884 still much greater than just above or below. Its great value was probably due to the cut-offs. In 1884 the distance from Lake Providence to Vicksburg was 57 miles; the sum of the two cut-offs was 18 miles. If we suppose that before these two cut-offs the river was two-thirds of this 18 miles longer than now, or the distance from Lake Providence to Vicksburg to have been 69 miles, the slope would have been but fifty-seven sixty-ninths of its present value. The result of the cut-offs would be to increase the velocity of the river above and near them. This increase of velocity would tend to scour the bed and banks, perhaps making a deposit in the river below the Davis cut-off, and temporarily raising the bed there; and it may be that it is now returning to its normal low-water position by removing the deposits below.

(6) *Red River Landing.*—The low-water record is continuous back to 1872, which was the year of the lowest known low water, the gauge reading 0.0. In 1879 it fell as low as 0.55, and in 1887 to 0.47. The difference in low-water heights of 1872 and 1887 is too small to be evidence of a rise in the bed of the river.

Thus far only low waters of the Mississippi have been considered. The high water records cover longer periods, but as an increased high-water may result from confining the flood between lines, as well as from a rise of the bed of the river, it can not be concluded from a rise of flood height in the river that the bed has also risen. At Cairo—

	Feet.
June 21, 1858, the gauge read	49.6
May 2, 1862	50.8
March 21, 1867	51.0

The river did not again reach these heights till—

February 26, 1882	51.87
February 27, 1883	52.17

The increase in the later heights is not supposed to indicate any rise of bed, but can be accounted for solely by a greater flood or discharge.

At Memphis the record goes back to 1828. In 1862 the river reached a flood height of 34.45, the record then showing no greater one. In 1882 the greatest height was 35.15; in 1887, 35.30; and in 1890, 35.60. This rise of 1.1 feet since 1862 may be accounted for by a greater discharge, by the construction of levees below Memphis, and, perhaps by the influence of railroads across the St. Francis bottom, without the supposition of a rise of bed.

At Vicksburg the record goes back to 1828. The highest known water was 51.1 feet, in 1862. The next highest was 49.1, March 15, 1890. Here there is no indication of a rise of bed.

At Natchez the record goes back to 1828. The highest water was 49.9, in 1862. In 1890 the highest water was 48.6, on March 22. In 1815 the highest water was 48.5. There is no indication of a rise of bed.

From an examination of the Po and Rhine, it may be concluded that if their beds rise in the leveed portion (which is not entirely certain from the data), it is at so slow a rate as not to be an important factor in the maintenance of a levee system. With levees 10 feet high, if the bed rose at the rate of 1 foot in a hundred years, the cost of raising a line of levees having the length of the present Mississippi system—about 1,300 miles—by this one foot, would be but about $4,000,000, distributed over the country, or $40,000 per annum, which is a small part of the annual cost of the system.

On the Mississippi, the records, while not extending over a period long enough to give final results, do not, as far as they go, indicate that the bed has risen.

The opinion so often held, that levees cause a river bed to rise, is probably due to the fact that the bed of a river does sometimes rise, although leveed, and hence it is concluded that the levees cause the rise. Any sedimentary stream, having a definite succession of stages and discharges, and flowing in its own alluvion, finally takes such a slope as will give a velocity sufficient to enable it to carry its sediment, whether derived from above or from its own banks and bed farther down stream, without, on the whole, scouring or filling its bed. An average velocity less than this will give rise to deposits in its bed, or if it is crooked, it will become straight, thus in either case increasing its slope and velocity towards their normal values. An average velocity greater than this will scour its bed or cause caving in its convex bends, thus increasing its length and diminishing its slope and velocity to such values as its bed can bear without, on the whole, scouring or filling. When, therefore, the slope of a sedimentary stream suddenly diminishes from that which it needs for stable regimen, its velocity also diminishes; it drops a part of its alluvion, and its bed rises. Thus, when the Mississippi enters the Gulf of Mexico, its slope suddenly diminishes, its velocity diminishes, and it builds up bars out in deep water. So Bayou Lafourche, when its waters fall to the level of swamps but a few feet above Gulf level, builds up its bed, necessitating high levees. So, too, the Adige, where it reaches the low plains of the Po, needs for permanence a steeper slope than the country has, and raises its bed above it. In all these cases the bed would rise without levees.

The is one more cause for the rise of bed of a sedimentary river, which, however, acts at a very slow rate. The Mississippi pushes its mouths out into the Gulf at the rate of about 4 miles in a century, and this increase in length requires a corresponding increase in fall of water surface to make the waters flow out. An increase of 4 miles in length would, with existing slopes, raise the high-water

surface at New Orleans about .7 foot. The cost of raising levees to correspond with this rise per century in the water surface would, as has already been seen, be a small part of the annual cost of the system.

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STATEMENT OF LIEUT. COL. CHAS. R. SUTER.

Lieut. Col. CHARLES R. SUTER, U. S. A., a member of the Mississippi River Commission, appeared before the committee.

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Lieutenant Colonel SUTER. The Commission was organized in 1879. The first report that the Commission submitted in accordance with the law organizing it considered various plans that had been presented at various times for improving the Mississippi River. They were defined in the bill as the outlet plan, the levee plan, and and what was called the jetty plan. The Commission reported upon all three plans and then made their recommendations as to what they proposed.

The so-called outlet plan was condemned *in toto*. The plan of improving the navigation by levees alone was not adopted by the Commission.

Of course as a protection against overflow they were unanimously favored by the Commission. The closure of the then existing gaps was recommended, as it was considered that the levee system would form an important auxiliary in channel improvement when taken in connection with the other work which was recommended. The Commission were of the opinion that an approximately uniform regimen of the river should be aimed at, and that the control over the river should extend through all its stages, including high water, which of course brings in the levees as a factor in the channel improvement. I will state that when I speak of a uniform regimen of the river I mean that the object is to introduce as nearly as possible similar conditions throughout, so that there will be no abrupt changes in its main features.

The river in its present state varies from 2,000 feet to over 10,000 feet in width, with corresponding variations in velocity and everything connected with it. The idea was to bring it into something like uniformity. Of course it was not considered advisable that the minimum width should be taken as the standard. The minimum width I think is 2,000 feet. It is not considered necessary to go that far, but the Commission found on investigation, from such surveys as were available, that a width at low water of about 3,000 feet would give sufficient depth for all navigable purposes, and the plan formulated was to reduce the river to this width at low water by proper contraction works. The kind of contraction works proposed were what may be denominated silt-catching works. They consist of systems or combinations of dikes made of piles and carrying brush screens, so designed as to check the current over certain selected portions of the river bed and induce there deposits of silt, so that ultimately the river may rectify itself by reclaiming those por-

tions of the bed which are not needed for the navigable channel and building up new banks. Eventually these shoals become the training dikes just as ordinary dikes do on rivers of the usual character. It is a system of improvement only possible on a sediment-bearing stream.

The second feature of the proposed plan was the revetment of banks where exposed to erosion, the idea of course being to make the current act on the bottom instead of the banks, in order to deepen the channel.

These two constitute the main elements of the channel improvement in the bed of the river; that is, permeable dikes to induce deposits, and revetments to hold the banks and keep the river in place. The maintainance of levees on the top of the banks was thought by the Commission to subserve two purposes. In some places there is very little question that the navigation of the river has been seriously deteriorated by the existence of breaks in the levees. That, of course, is especially manifest in those portions of the river that have been leveed for a long time; that is, where the system of levees has been kept up for a great many years.

It has been found by measurement that below extensive gaps in levees there is a very decided deterioration in the channel, and the Commission were of the opinion that this deterioration is due to the existence of these gaps; hence their inference was that if those gaps in the levees were closed the deposits formed under the influence of the crevasses would be swept away and the channel of the river correspondingly improved and deepened. Furthermore, levees were deemed essential, both for the safety of the works in the bed of the river, and to maintain the regimen at those places where it was already good. The only way to obtain uniformity of regimen, or to keep it when obtained, is to control the entire discharge of the river, which of course means the control of the floods as well as low stages. At the period of flood discharge you have an enormous volume of water, capable of almost any amount of mischief; at that period the cut-offs are formed and all sorts of accidents of that kind occur, all of which tend to upset the uniform regimen you are endeavoring to get.

From this point of view the function of the levee system may be considered as conservative; its other function confers a direct benefit. The plan of the Commission contemplated both of these functions and these three factors; that is, the channel contraction works, the revetment of the banks, and the levees on the top of the banks constitute the plan on which the Commission has worked from that day to this.

Senator GIBSON. Do you know what effect the levees have had on the navigation anywhere?

Lieutenant-Colonel SUTER. Yes, sir; I think they have had a very decided effect at Lake Providence, and also to a certain extent at Plum Point. At Plum Point the levees have been constructed by the Commission purely and entirely to improve navigation. They

are local levees, on both banks of the river, and the effects have been very marked.

Senator GIBSON. You stated a moment ago in reply to a question by the Chairman that if you were improving the Mississippi River, even if it were running through a wilderness, if the country through which it ran was not peopled, you would still build levees on the banks.

Lieutenant-Colonel SUTER. Yes, sir.

Senator GIBSON. Why do you hold that opinion?

Lieutenant-Colonel SUTER. Because I consider that the improvement of the stream for navigable purposes; without it is impossible.

The CHAIRMAN. Why?

Lieutenant-Colonel SUTER. I think you have got to retain control over the whole volume of water. The discharge which passes within the banks is less than half of the flood discharge of the river, and the low-water discharge is only about one-tenth of that which passes within the banks, about one-twentieth of the total discharge, and any works that you can put in to control the low-water flow on a stream like the Mississippi are liable to be utterly destroyed and rendered nugatory by the vastly larger volume of water which passes down the river during flood stages. At this season of the year the cut-offs occur, which will upset any plan of improvement, because they change entirely the regimen of the river, its course, its slopes, and everything about it.

Again, the water being over the works and everything else, has a chance to develop new channels precisely where you do not want them to occur. A still further effect is produced where the levees are down; the water that goes over the banks keeps going out and coming back again. Whenever it makes its appearance in the river it acts like a tributary. It produces entirely new phases, just as any tributary will. Sometimes it entirely reverses the conditions of flow. The influence that levees exert under these heads I believe I have stated as conservative. They prevent the river from doing damage to the works we put in to improve the low-water discharge of the stream.

The CHAIRMAN. If there was no question about protecting the land, and you were simply improving the Mississippi River for navigation, would you have built the levees that are now built?

Lieutenant-Colonel SUTER. Yes, sir.

The CHAIRMAN. You say you would?

Lieutenant-Colonel SUTER. Yes, sir.

The CHAIRMAN. So that, regardless of the question of the land owners, you say that this Commission has done none too much toward levee building.

Lieutenant-Colonel SUTER. That is my opinion.

The CHAIRMAN. Do you not think the people whose lands are preserved by these levees should pay a part of the expense of constructing them?

Lieutenant-Colonel SUTER. That is hardly an engineering question. I think, however, the same question might be asked with re-

gard to other improvements. For instance, one of the most important features of the work of the Commission is the protection of the banks from caving. In doing that we do it entirely in the interest of navigation, but it does at the same time prevent many a man's plantation from caving into the river.

The CHAIRMAN. In other words, you think the levee is a part of your system as well as the jetties?

Lieutenant-Colonel SUTER. Yes, sir.

The CHAIRMAN. You mean to say that these dikes and levees are necessary to preserve the channel of the river itself?

Lieutenant-Colonel SUTER. Yes, sir.

The CHAIRMAN. The permanency of the channel?

Lieutenant-Colonel SUTER. Yes, sir; that is my view.

The CHAIRMAN. How long did you say you had been on the river?

Lieutenant-Colonel SUTER. Since 1866.

IMPROVEMENT OF THE MISSISSIPPI RIVER.

STATEMENT OF CAPT. SMITH S. LEACH.

Capt. SMITH S. LEACH, United States Engineers, in charge of first and second districts of the Mississippi River, appeared before the committee.

The CHAIRMAN. How long an acquaintance have you had with the Mississippi River?

Captain LEACH. Since 1878.

The CHAIRMAN. Are you a member of the Commission?

Captain LEACH. No, sir; I am a subordinate officer of the Commission.

The CHAIRMAN. Where are you located?

Captain LEACH. At Memphis.

The CHAIRMAN. State what your experience with the river has been.

Captain LEACH. In the summer of 1878 the board of engineers was organized which was referred to here by General Comstock and others. I was then second lieutenant of engineers and was assigned to duty as recorder of that board. That board undertook extensive surveys, examinations, hydrometric measurements, etc. The field-work of a large part and the computations of all of these were placed in my immediate charge. I began from that time to study this question from the original data and measurements made upon the stream itself, and I have done nothing else professionally from that day to this.

The CHAIRMAN. Have you observed the overflows of the river?

Captain LEACH. Repeatedly. I have been over the river in its whole length and at almost every stage of water.

The CHAIRMAN. State to the committee as briefly as you can your idea of the improvement of the Mississippi River for navigation.

Captain LEACH. To start with what should not be done, I would mention the project of taking off any portion of the water of the natural discharge of the river at any stage whatever or for any purpose, or at any point. The salient point in connection with that topic is, first, the question of the effect upon the channel of the river above and below resulting from taking off such water under such circumstances. I have here a complete map of the delta of the Mississippi showing its approaches to the Gulf. I may state a fact, which I do not think will be denied by any one, that this single-trunk channel as it approaches the Head of the Passes is one of the finest navigable flowing streams on the face of the earth. It is of reasonable width, very deep, and has at all times a regular and

moderate current. At a point here [indicating on map] it is divided into three principal branches. Each one of those branches is narrower and shallower and more irregular in its regimen than is the main stream. This is the Head of the Passes [indicating on map].

At this point, where this main stream is divided into three branches, the phenomenon is presented of a large and deep and good channel being transformed into three narrow and shallow and poor channels. A great deal of talk has been heard about the difficulty that Captain Eads had in removing the bar at the mouth of South Pass bar. If he were here to-day he would confess a much more serious difficulty in dealing with the shoal water at the head of that pass. This is the bar that gave him the real difficulty [indicating on map]. This is the bar at the Head of the Passes at the point of diffusion, at this point division of the main stream. It was to get a greater depth over this bar at the Head of South Pass that he laid a sill over the other two passes, and constructed the funnel-shaped prolongations of the natural banks of this pass in order to augment the flow of water through there.

We have these three passes, each having a bar at each end, and each being 30 feet average depth between the bars in its original and natural condition as against 125 or 130 feet depth of the main stream. Here is the South Pass [indicating on map]. This is the one that has the great depth. This is the one that carries from 26 to 30 feet. This Southwest Pass carries less than that, perhaps 16 feet.

Now, the point I make is this: This phenomenon occurs here [indicating on map]. It occurs at the corresponding point on every known alluvial sedimentary stream on the face of the earth that branches into a delta formation.

Now if the degradation of these subsidiary channels occurs here when the stream divides into three parts, why will it not occur at Lake Borgne if you there divide it into two? The fact can be explained on no other hypothesis than that in division there is weakness, a proverb more familiar in the universe terms "In union there is strength." I never heard any other advanced for it, and its converse, which the outlet theory demands for its support, is not only absurd on its face, but contradicts every fact of the river's life which has come to my knowledge. Anything further on the subject of outlets is only an elaboration of that general statement. To substantiate that, if proof should be necessary, there are frequent observations in the bed of the river itself. These consist of a large number of exact measurements, as precise and accurate for that purpose as would be any measurement that could be made of the length of this Capitol building. We have not guessed at this thing; we have measured it, and we had no theory to establish when we made the measurement, but we made the measurement for the purpose of finding out the theory.

The measurements have shown conclusively in repeated instances that when a crevasse occurs the channel for a few miles immediately below becomes distinctly smaller. When that crevasse is closed, measurements made before and after the closure have shown that

this loss in the area of the channel is recovered. When a crevasse is closed and immediately after that closure—let me change the form of that statement—when a crevasse opens and immediately after that opening by exact measurement there is found to be a deterioration of the channel of about 12 per cent. of its area, and again when this same crevasse is closed after the next succeeding flood, there is found to be a recovery of this 12 per cent. lost, I do not think any other hypothesis will explain it.

Second in importance will be the deterioration of the navigable depth in this channel which is now an extraordinary good one, and which can be maintained there, as the experience of the last ten years has shown, at a very trifling expense. If that channel were injured and deteriorated by the natural and inevitable result of taking off a large portion of the flood discharge at a point higher up the river, you would then, instead of having little or no expense to keep it open, have an enormous annual expense, and even then the condition of the channel would be so precarious that the effect on commerce would be very detrimental. Ships will go to a port where they know they will find 26 feet of water, without doubt, more readily than they would go to a port where they were promised 30 feet and might find but 20. A reliable 26-foot channel is better than a precarious 30-foot channel

The CHAIRMAN. You are familiar with the methods of the Mississippi Commission as to improvements?

Captain LEACH. Will you bear with me a little further on this topic?

The CHAIRMAN. Yes, sir.

Captain LEACH. The question has been discussed over and over again as regards the elevation of the bed of the river as the result of the construction of levees, and also as to the deterioration of the channel below the outlet. I know of no engineering authority that can be quoted in support of this view except by garbling, and as you have had a little garbling already before you I would like to read some full and complete extracts. I have before me the report of Colonel Ellet. I would like to read a few extracts from it; it will take but a moment. I will read the introduction pretty much *in extenso*.

The CHAIRMAN. When was that report made?

Captain LEACH. Eighteen hundred and fifty. It is a report and the only one I know of where an engineer of any standing has deliberately and definitely proposed to make a certain definite outlet.

In this paper the causes of the more frequent and more extensive overflows of the delta of the Mississippi in recent than in former times are considered, and plans suggested for the mitigation of the evil.

The greater frequency and more alarming character of the floods are attributed—

Primarily, to the extension of cultivation throughout the Mississippi Valley, by which the evaporation is thought to be in the aggregate diminished, the drainage obviously increased, and the floods hurried forward more rapidly into the country below.

Secondly. To the extension of the levees along the borders of the Mississippi, and of its tributaries and outlets, by means of which the water that was formerly

allowed to spread over many thousand square miles of low lands is becoming more and more confined to the immediate channel of the river and is, therefore, compelled to rise higher and flow faster, until, under the increased power of the current, it may have time to excavate a wider and deeper trench to give vent to the increased volume which it conveys.

Thirdly. To cut-offs, natural and artificial, by which the distance traversed by the stream is shortened, its slope and velocity increased, and the water consequently brought down more rapidly from the country above, and precipitated more rapidly upon the country below.

Fourthly. To the gradual progress of the delta into the sea, by which the course of the river, at its embouchure, is lengthened, the slope and velocity there are diminished, and the water consequently thrown back upon the lands above.

It is shown that each of these causes is likely to be progressive, and that the future floods throughout the length and breadth of the delta and along the great streams tributary to the Mississippi are destined to rise higher and higher as society spreads over the upper States, as population adjacent the river increases, and the inundated low lands appreciate in value.

For the prevention of the increasing dangers growing out of these several co-operative causes six distinct plans are discussed and advocated:

First. Better, higher, and stronger levees in lower Louisiana, and more efficient surveillance—a local measure, but one requiring State legislation and official execution and discipline.

Second. The prevention of additional cut-offs; a restraint which may call for national legislation, or possibly judicial interference to prohibit the States and individuals above from deluging the country below.

Third. The formation of an outlet of the greatest attainable capacity from the Mississippi to the head of Lake Borgne, with a view, if possible, to convert it ultimately into the main channel of the river.

Fourth. The enlargement of the Bayou Plaquemine, for the purpose of giving relief to that part of the coast which now suffers most from the floods, viz., to the borders of the Mississippi from above Baton Rouge to New Orleans.

Fifth. The enlargement of the channel of the Atchafalaya for the purpose of extending relief higher up the coast, and conveying to the sea, by an independent passage, the discharge from Red River and the Washita.

Sixth. The creation of great artificial reservoirs, and the increase of the capacity of the lakes on the distant tributaries, by placing dams across their outlets, with apertures sufficient for their uniform discharge—so as to retain a portion of the water above until the floods have subsided below. It is proposed by this process to compensate, in some degree, for the loss of those natural reservoirs which have been and are yet to be destroyed by the levees; and, at the same time, and by the same expedient, improve the navigation of all the great tributaries of the Mississippi, while affording relief to the suffering and injured population of the delta.

Now I read again from part 2 of Prolongation of the Delta:

It is a popular belief that the bed of the Mississippi is gradually *rising*, and to that assumed cause is not unfrequently attributed the constantly increasing height required for the protecting levees. But this belief can be traced to no better evidence than the fact that certain points which formerly exhibited deep soundings have subsequently become shallower, a circumstance which is attributable altogether to the shifting nature of the shore and bottom of the river. As consequences of the changing and movable character of the soil through which the Mississippi flows, shores which are at one period curved subsequently become salient; banks that at one time wash and cave in, at a later date fill up; places which during one period are gradually growing deeper, at another become less deep and to the sounding-line indicate an elevation of the bottom. There is, in fact, no evidence of any change in the general level of the river's bed beyond what may be inferred from the evident prolongation of the delta, the lengthening out of the course of the stream, and the consequent diminution of the plane of descent. But this elevation of the bed is not indicated by any increased depth of the stream, though it must of necessity occasion a corresponding elevation of the surface. Any increase in the height of the floods produced by a given body of water discharged in a given time, beyond what may be justly attributed to this extension of the delta, must, therefore, be sought in other adequate causes.

It is customary to point to the Po in evidence of the effect of embanking the coasts of streams in producing an elevation of the bed of the river. And it is

assumed that because the bottom of the Po and of all rivers that empty into the Adriatic is to be found in the great quantity of earthy matter which they transport to the sea, and the shallowness of the gulf into which this material is conveyed, this deposit in the course of twenty centuries has produced a prolongation of the delta of the Po, estimated at about 25 miles, and has converted cities which at the commencement of the Christian era were respectable sea-ports into inland towns, at this day 20 miles from the sea-shore.

Senator GIBSON. You mean to say that more modern investigations have shown that the Po did not rise.

Captain LEACH. At the time that Colonel Ellet was writing in the United States, Lombardini had written in Italy a complete refutation of De Prouy's conclusions as to the bed of the Po rising. Lombardini's researches were probably not known to Colonel Ellet, who, feeling himself obliged to accept the current belief that the bed of the Po had risen, is so confident that levees had and could have nothing to do with it that he takes pains to bring forward another explanation.

Cut-offs are mentioned in this outlet scheme as being in the dim future desirable to be done.

Among the causes of inundations that have recently produced so much loss and distress on the lower Mississippi, in the opinion of the writer, must be enumerated the cut-offs which have been made at and below the mouth of Red River. It is true that men of science have denied and do still contest this point. But the opinion here entertained rests on what are deemed to be the natural laws of the flow of the river, and, moreover, on indisputable results. The theory which is entertained by many intelligent persons, that by shortening the channel and cutting off the bends of the river the velocity of the current will be increased, the channel scoured out wider and deeper, the floods conveyed more rapidly to the sea, and the surface therefore reduced, is all perfectly true, excepting the practical conclusion.

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After describing outlets in full he says:

But, in addition to all this, the protection of lower Louisiana will require other expedients. For this State, indeed, there is no alternative. She can not wait for Congress to discuss, doubt, survey, and appropriate. She can not wait for the slow machinery of legislation. She must build levees without hesitation or delay, or see her fields annually swept by the floods.

* * * * * * *

But, while recommending these prompt and vigorous measures, it is the duty of the writer to express his conviction that, after all these means of relief, carried as far as prudence and proper regard to economy and the interests upon which this excess of water will be turned, have been exhausted, they will be found insufficient to secure even the State of Louisiana against the floods which, at no distant day, will be poured down the Mississippi, while the great area subject to inundation in the States of Arkansas and Mississippi can receive no sensible relief from any of these expedients but that of levees. To secure the whole delta it will be necessary to commence promptly and press vigorously the great work of retaining the water in the mountains.

This is the reservoir idea. There are more of these extracts than I thought there were. I think I have read all that are really important, and I hope enough to give you the opinion that the idea, the tenor of this report, as previously put before you, is erroneous. I hope it was unintentionally done, but I can scarcely believe it.

Now, if this report is read, the impression is obtained that Colonel Ellet was in apprehension of a perfectly appalling increase of floods in the Mississippi. He goes so far as to say that he thinks in no long period of time the increase of floods due to the progress of deforesting and the extension of cultivation and drainage, together

with the building of levees, will cause an increase in the height of the floods of 18 feet at Red River. Since that time deforesting has gone on for forty years, and I believe now is about at a maximum. I think that tree-planting is keeping pace with deforesting. Cultivation and drainage have gone on in the Mississippi Valley, and have gotten nearly as far as they are going, and we have had no such elevation of floods. We have as yet had no floods that could not be restrained with levees of moderate heights.

Such floods as Colonel Eilet anticipated have never been realized; never will be; never can be. The whole tenor of his report shows very plainly that he was forced to accept the outlet theory against his deeper conviction, simply because he thought that no levees which could possibly be built would restrain the floods which he expected in the future.

His idea was that the extension of the levees would hurry forward the discharge from above. The elevation of the flood-line would begin at Cairo and increase until it reached this figure, 18 feet at Red River.

Subsequent experience has shown that these apprehensions were entirely unfounded. We get a good illustration of that from the Po at Ferrara, which occupies a position on the Po about the same as that of Vicksburg or Natchez on the Mississippi. The super-elevation of the flood surface within the history of the Po for several hundred years, due to the extension of levees and other causes, is about 3 feet. It is reasonable to suppose that the super-elevation caused by the hastening forward of the discharge of the floods will bear some relation to the slope of the river and its size. In slope the Po leaves off at the sea about where the Mississippi begins at Cairo. If the hastening forward of the flood on the Po, with a slope of from 30 inches per mile at its head-waters to 5 at the sea, results in an increased height of 3 feet at Ferrara, we may reasonably expect that the super-elevation of floods due to the same cause on the Mississippi will be less in amount—less than 3 feet—since the greatest slope of the latter stream is but little in excess of the least slope of the former.

The CHAIRMAN. In how long a period?

Captain LEACH. Forever; the causes of increase must culminate at some time.

The CHAIRMAN. Captain Leathers says the bottom of the river has risen 7 or 8 feet now.

Captain LEACH. I know he does.

The CHAIRMAN. What do you say about that?

Captain LEACH. The gauge records show that the absolute elevation of the low-water surface is about, as nearly as can be figured, where it always has been at various points. Captain Leather runs his boat through low water, at about 7 feet depth, and if the bottom has risen 7 feet, the surface remaining stationary, he would have no water to run his boat through. He would have to run it on wheels. The low-water surface has not risen. We have unquestionable evidence as to that. We have measurements just as good as any man can make. We have records that have been made at various places

by a great many different people, so that there could be no collusion about it, no mistake about it. They agreed perfectly; they are consistent with each other. Their reports are that the low-water surface is exactly where it was for about the same volume of discharge. The records at Natchez go back to the beginning of this century.

The CHAIRMAN. Captain Leathers says the bottom of the river has risen at Memphis.

Captain LEACH. I do not know what Captain Leathers has stated. The records at Memphis show nothing of the kind.

The CHAIRMAN. Now, captain, the committee will be glad to have you give your views as to the plan the Commission have adopted to improve the river.

Captain LEACH. As to the improvement of the river, I do not know that I have anything new to add over and above what has been stated. The plan of the Commission has been outlined. The degree of success that has been attained has been stated. In all those points I can do no better than to say that I fully concur.

The CHAIRMAN. General Comstock says that in his opinion levees are not necessary to improve the navigation of the Mississippi River, while Major Suter says that in his opinion the levees are essential. What is your opinion about that?

Captain LEACH. My opinion is that they are absolutely essential; that there are certain well-defined possibilities to the improvement of the Mississippi River. There are certain natural conditions present which by proper scientific treatment can be made to produce a stream of a certain degree of navigability. It has its ultimate possibilities. With levees that possibility can be attained; without levees it can not. Without levees a stream can be improved; with levees it can be improved much more. That is my idea of the river with and without the levees.

The CHAIRMAN. General Comstock, what is your view—is it best in making an appropriation of two or three millions for the improvement of the Mississippi River to direct the expenditure of money at particular points?

General COMSTOCK. If the money is intended to be spent in protecting towns and cities and villages along the river, that object will be attained by that process, but probably there will be very little left for the improvement of the river generally.

The CHAIRMAN. Has not the Commission, so far as navigation and its interests are concerned, been very much crippled by the action of Congress in thus disposing of its appropriations?

General COMSTOCK. I think so in some degree, because I think Congress would have given us probably a larger amount for the general improvement of the river, if they had not made specific appropriations. For instance, in the last bill there was an appropriation of fifty or sixty thousand dollars for Columbus, some for Greenville, and so on down. Those were all places where money would come out of what we otherwise would have had to use for the general improvement of the river.

The CHAIRMAN. Major Suter, I want to ask you the same question.

Major SUTER. My opinion is about the same as General Comstock's.

Captain LEACH. That is a question rather higher in the horizon than I have ever been called upon to consider. I am only a subordinate. I have tried to execute the plans of the Commission and to carry out the will of Congress expressed in the law, and in regard to probable or possible improvement in the method of making appropriations I do not know that I have any opinion to express.

Senator WASHBURN. I would like to ask a question. Suppose Congress should appropriate two and a half or three million dollars for the improvement of the lower Mississippi without restriction, how would it be expended by the Mississippi River Commission?

General COMSTOCK. I can answer that. I do not think it would be an unjust distribution to make the distribution we have made heretofore, two-thirds for the improvement of the river and one-third for the levees.

Senator GIBSON. Captain Leach, you are not a member of the Mississippi River Commission?

Captain LEACH. No, sir.

Senator GIBSON. I suppose shortly after you graduated from West Point you were assigned to the Mississippi River Commission.

Captain LEACH. I graduated in 1875, and in 1879 I was assigned as secretary of the Commission.

Senator GIBSON. Did you have any preconceived notions as to how the river should be treated?

Captain LEACH. Not at all.

Senator GIBSON. Your opinion is based upon your experience and observation on the river?

Captain LEACH. Entirely so.

Senator GIBSON. Are you a native or a resident of the valley of the Mississippi.

Captain LEACH. No, sir; I am a native of Indiana.

Senator WASHBURN. You do not agree with Colonel Ellet in the opinion that these outlets, what you call high-water outlets, are desirable?

Captain LEACH. No, sir.

Senator WASHBURN. Under no condition of things?

Captain LEACH. No, sir; because the conditions under which Colonel Ellet arrived at the conclusion he did were predictions for the future. We are now in a good part of that future. We see that those predictions will not be realized.

Senator WASHBURN. Why should not the same principle apply? We have had very high water this year, perhaps not as high as he contemplated, but certainly very high. Why should not the same principle apply in the very high water we have had this year as he contemplated?

Captain LEACH. The best method of controlling a flood is by levees. There are physical limits to the building of levees, and if a flood went so high as to exceed those limits, then it would be nec-

essary to obtain relief. It was under such apprehension, in my opinion, that Colonel Ellet proposed an outlet.

Senator WASHBURN. Major Suter takes the position that the river with these outlets would not discharge the water as rapidly as though it were held in one channel.

Captain LEACH. I think it is fully agreed that there would be an immediate relief. The great destruction will come on the second or third generations hence, and of course if a man is under water he will get out, regardless of what is going to happen to his descendants.

Senator WASHBURN. You think that by making these outlets, take the Atchafalaya, we would afford immediate relief from the great floods?

Captain LEACH. It would afford slight local relief from the pending flood, undoubtedly.

Senator WASHBURN. In other words, it would discharge the water more rapidly than though you attempted to maintain it in one channel?

Captain LEACH. I do not know.

Senator WASHBURN. You would get rid of it?

Captain LEACH. Yes, sir; it would reduce the level slightly. Two years ago I thought myself, and stated before a committee of this Senate that I thought it possible to reduce the surface 10 feet by opening the Lake Borgne outlet. I should be compelled to divide that by 2 now—5 feet, by any possible outlet.

Senator WASHBURN. And you hold still further that the degree of elevation would decrease as the years went by?

Captain LEACH. Very much. The scope of the river to the mouth of the passes would be increased. Now, if you want to increase the inclination of a line, one end of which is fixed, it can only be done by raising the other end. The Mississippi River from the Gulf to New Orleans is such a line. Its lower end is fixed at Gulf level, and if it is compelled by division to take a steeper slope, it can only do it by raising its level at New Orleans. The divided channels must inevitably take a higher slope, and in doing so the point of their divergence must be elevated absolutely.

Senator GIBSON. And that would make a bar.

Captain LEACH. Unquestionably, and it will raise the flood line also. Nothing else you can do will elevate the flood plane so certainly. In fact, that is the one solitary thing that must give New Orleans bigger floods than ever before.

The CHAIRMAN. Captain Cowden wants me to ask you certain questions. Would you levee-dike, spur-dam, etc., the upper end of a sediment-bearing stream before you would improve the lower end of such a stream?

Captain LEACH. That would depend entirely upon the conditions. If the lower end demanded improvement in the interest of navigation and the upper end did not, I would sacrifice my theories and improve the lower end first, provided I held such theory, and on the converse, if the upper end demanded improvement and the lower

end did not, I would improve the upper end. I would improve the end which first demanded it.

The CHAIRMAN. Will water flow down an angle or incline of 2 inches to the mile faster than it will flow down an incline of 1 inch to the mile.

Captain LEACH. Not necessarily. It may flow very much faster down the lower inclination.

The CHAIRMAN. The same volume and the same width?

Captain LEACH. No restrictions with regard to volume were made. I was only asked one question with regard to velocity and slope. The velocity depends, as nearly as it can be stated in brief terms, on the square root of the angle of the fall and the square root of the mean depth. To increase the mean depth will increase the velocity just as much as an equal increase of slope. The average mean velocity of high water from Cairo to New Orleans does not differ very much from 6 feet in a second; that regardless of considerable changes in slope. Repeated observations, hundreds of them, are available to show that there is a remarkable uniformity in the mean flood velocity from Cairo to the Gulf.

The CHAIRMAN. Is the fall greater at Cairo than at New Orleans?

Captain LEACH. It is.

The CHAIRMAN. Is the current greater at Cairo than at New Orleans?

Captain LEACH. A little greater at low water, but at high water it is almost the same.

The CHAIRMAN. Then does not the greater current above bring the mud down faster than the slower current at the lower end can discharge it?

Captain LEACH. There is no greater current above.

The CHAIRMAN. If you build levees higher at the lower end than at the upper end, does that increase or decrease the angle of fall?

Captain LEACH. I do not think it has any effect at all.

The CHAIRMAN. It is claimed that the inflow of water is 2,100,000 cubic feet per second, and that the outflow of water at the mouths of the Mississippi is 1,100,000 cubic feet per second, and, if this be true, how would you prevent overflows?

Captain LEACH. By one of the best known principles of river physics, that is, that there is a very appreciable reservoir effect in the volume of the channel itself. If the water is flowing in at Cairo faster than it is flowing out at New Orleans and I am asked where the surplus goes, I am able to reply that it goes to raising the surface of that water. There are thousands of square miles of water to be raised and it rises sometimes in places as high as 2 or 3 feet a day.

The CHAIRMAN. Is the South Pass in any sense an outlet of the Mississippi?

Captain LEACH. Yes, sir.

The CHAIRMAN. Are the mouths of the Mississippi in any sense outlets?

Captain LEACH. In every sense.

The CHAIRMAN. If you wanted to get the floodwater of the Mississippi into the Gulf of Mexico quicker than it would now flow through the present mouths, would you close up all of the present mouths or would you open more outlets?

Captain LEACH. I certainly should not close up all the mouths of any stream under any circumstances. I admit that I would leave at least one open.

The CHAIRMAN. Would you open any more outlets?

Captain LEACH. No, sir.

The CHAIRMAN. If it were possible to make the Lake Borgne outlet wide enough and deep enough to lower the flood-line of the Mississippi River at that place down to the Gulf level, would that enormous outflow of flood water increase or decrease the current of the Mississippi River?

Captain LEACH. It would increase the current for a short distance above enormously and it would decrease the current below. In fact, if the hypothesis stated were realized, there would not be any current at all below except a little ebb and flow of the tide, and of course it would increase the current enormously above, it would aggravate the destruction of the banks, and in that way would not only make the maintenance of a levee system along there very precarious, but it would make the work of regulation of the stream very difficult.

The CHAIRMAN. How does this year's floods compare with floods of previous years?

Captain LEACH. The data are not in yet. There are some peculiar developments that would require study before expressing a definite opinion. I would say as the result of what I have seen that I believe the flood at Memphis was about 5 per cent. less than in 1882, the greatest in volume we have ever had, taking the whole length of the river. At Helena it approached closely to the 1882 flood, and below Helena it was the greatest flood of record in every respect except one, duration. In every other respect it was the greatest flood on record.

The CHAIRMAN. How does the land actually overflowed compare with that of 1882?

Captain LEACH. About 20 per cent. as much.

Senator WASHBURN. Twenty per cent. less than in 1882?

Captain LEACH. Only 20 per cent. of what was overflowed in 1882.

The CHAIRMAN. What do you charge that to?

Captain LEACH. The levees. The overflow was made possible by the breaks in the levees. There were breaks of less than 2 miles, perhaps, in 1,300 miles. I may say, generally speaking, in regard to the possibility of maintaining a levee system for restraining floods, we have this year with the greatest flood on record approached more nearly the complete restraint of the flood than ever before.

The CHAIRMAN. Suppose the levees had not broken, would the overflow not have occurred?

Captain LEACH. The river was almost at its height before the breaks began, and from information which will be placed before the

committee later it will be seen that the taking out of a very large quantity of water, at one place 400,000 cubic feet per second, had a very slight, unexpectedly slight, effect in reducing the height of the river. It is perfectly reasonable to suppose that an addition of 400,000 cubic feet per second would have had no greater effect in raising the river than the outlet had in depressing it. I think there is a great deal of evidence to show that with grades in some parts 2 feet higher than we now have, and in other parts no higher than now, and with levees thoroughly policed and controlled from the beginning of the flood, there would be few or no breaks.

The CHAIRMAN. What was the difficulty?

Captain LEACH. Defective foundations.

The CHAIRMAN. Whose fault is that?

Captain LEACH. I do not know exactly where to put it.

The CHAIRMAN. Were they built by the United States Engineers?

Captain LEACH. Some of them, and some not; but the foundation was simply what nature left, not prepared foundations. I think, however, that we have underestimated the necessity of thoroughly exploring the foundations of the levee. I think all the engineers connected with the levee work are agreed upon that now.

The CHAIRMAN. Do the levees cave into the river?

Captain LEACH. Occasionally. The Commission within the last two or three years has distinctly committed itself to the policy of preferring, in the order of progress in bank protection by revetment, localities where the caving will involve large levees. I may say, generally, with regard to the history of the levee system, that over three-fourths, probably, of the entire sum of money expended by the States in the last ten or fifteen years in the construction of levees would have been saved if the United States had prevented the banks from caving.

Senator GIBSON. You said that this recent flood was the greatest flood of which you have any record?

Captain LEACH. Yes, sir.

Senator GIBSON. You mean in its height, or in its volume?

Captain LEACH. In its volume.

Senator GIBSON. You were speaking of the volume?

Captain LEACH. Yes, sir; but at some places it was greater in height.

Senator GIBSON. More water has passed down the Mississippi this winter in its flood stages than ever before?

Captain LEACH. I believe so; that is, below the mouth of the White river. The very top of this flood was caused by the discharge of a phenomenal volume of water out of the White and the Arkansas rivers upon the fairly large flood which was passing Memphis.

Senator GIBSON. Have you any knowledge, from tradition or data, of the flood of 1828?

Captain LEACH. There is some data on that subject, but I am not familiar with it now. I have not looked at it for a long time.

Senator GIBSON. Have you heard from old people living in the valley anything about the flood of 1828?

Captain LEACH. No, I have not. The only thing I know about it is that there is a paragraph about it in the Humphreys and Abbott report, and what data there is is collated there.

Senator GIBSON. You ascribe these breaks in the levees to the enormous body of water that pressed against them?

Captain LEACH. To the water against them, so long and with greater head than was ever known before in their history. By greater head I do not mean greater actual height of water in the river, but you know very well that if levees break extensively and back-water rises behind them, of course there is little or no head against them. In the flood of 1882 the levees, to be sure, were exposed to water perhaps 50 or 60 per cent. longer than this year, but this year they were mostly dry behind.

Senator GIBSON. What are the facts, first, as to the number of miles that gave away this year in comparison with the floods of 1882 or 1884 and so on, and, secondly, the number of breaks?

Captain LEACH. I have here the report of a number of engineers made to the recent Vicksburg convention. It is signed by about fourteen or fifteen engineers. This number comprises the United States engineers in charge of the district where the principal overflow occurred this year, two members of the Mississippi River Commission, and all the civil engineers engaged under all State organizations in the guarding and maintenance of levees during this flood. If anybody in the world has information about this thing these men have, and if any statement could be relied upon these gentlemen's statements certainly can.

The disasters from the recent flood have been exaggerated and magnified beyond their true proportions by the sensational treatment, and which has tended to shake confidence in the efficiency of the levee system. In confirmation of this, attention is called to the following:

In 1882 the total number of crevasses in the levees was 284, aggregating 589 miles in width.

In 1883 the number of crevasses was 224, with an aggregate width of 341.1 miles.

In 1884 the crevasses numbered 204, aggregating 106.04 miles in width.

The result of the crevasses enumerated during these three years were the general overflow of the Mississippi delta.

In the present flood, the dangers of which are nearly passed, the crevasses which have occurred number 23, aggregating about 4¼ miles in width in a total length of 1,100 miles of levee—one-half of 1 per cent. of the total line of levees, notwithstanding that the present flood has exceeded those of the three years cited in the height attained and all points below, and has not exceeded in duration.

Senator GIBSON. I wish you would state what levees constructed by the Mississippi River Commission, or in accordance with their plans, by the Army Engineers, have given away.

Captain LEACH. I really have no information on that point whatever.

Senator GIBSON. Has a single one given away?

Captain LEACH. I do not know. None of these levees are in my district.

Senator GIBSON. Yours is the Memphis district.

Captain LEACH. The first and second. This year we had but a single break, one at Austin, less than 300 feet wide.

Senator GIBSON. Built by the United States?

Captain LEACH. By the State.

Senator GIBSON. Has any of the work in your district built by the United States engineers given away?

Captain LEACH. No, sir.

Senator GIBSON. Are there any there?

Captain LEACH. Yes, sir; I have about 30 miles on one side and 15 on another, 45 miles in all, at Plum Point Reach, and about 15½ from Helena down. Half of this was built by the United States and all the Plum Point levees.

While I am on the subject of the Plum Point levees I would like to make a little statement.

The Commission in carrying out the work in the early years at Plum Point had not provided for any levees. In a debate in the Senate on one of the river and harbor bills the point was made by a Senator that the Commission was professing to make an experimental application of their system at Plum Point Reach and a part of their plan was a levee. That year an allotment was made and a levee built on the Tennessee side of the Reach. The next year an allotment was made for levees on the Arkansas side and those levees were built. A party was engaged all the time in making surveys. The surveys made after the construction of the second line of levees and before the first flood and again after the first flood showed that the high bars in the regulated or deepened channel of about 3,500 feet width had had their tops scalped off 8 feet uniformly. Nothing of the kind had ever occurred before, and in the two crossings under control and under improvement the maximum depths had increased in one case 1 foot and in another case 2 feet, and they have remained to this time.

The CHAIRMAN. Since the levees were built?

Captain LEACH. Yes, sir.

The CHAIRMAN. Have you any idea what it would cost to repair these levees?

Captain LEACH. That would depend entirely upon the scheme adopted. My belief is now that we can strike with much more certainty than ever before. This flood, with all its disasters, has convinced me, and others, I think, of what we before believed, but could not prove—that is, that we can with reasonable levees confine any flood we are likely to have, and it seems to me that instead of working as we have heretofore we ought to change the plan altogether and give a little more money and reduce the risk. I think it is perfectly safe now—a year ago I would not have dared to say so—to have a scheme of levees that will be almost impregnable, and to do that I suppose it will cost in the neighborhood of $10,000,000 at prevailing prices.

The CHAIRMAN. Ten millions for repairs alone?

Captain LEACH. To repair and enlarge and levee the St. Francis basin. To repair the present breaks alone, I think $100,000 will do at present rates. The breaks are not very large and do not occur

where the levees are very high. No very high levees have broken. The massive levees are all intact.

Senator WASHBURN. Let us understand what you propose to do with the $10,000,000.

Captain LEACH. Ten millions will put up a line of levees 4 feet above the highest known water, with strong profile on the west bank from Cairo to the mouth of the St. Francis. That is the first thing. It will also increase the work at Plum Point to that standard. It will build up the White River front from Helena to and including Laconia to the same grade and profile. It will enlarge the Arkansas levees from the high land at Ames Ridge down past Arkansas City and on past the State line down to Red River. It will enlarge the lower district of the Yazoo front, and make some enlargements from point to point as may be necessary in the upper district. It will increase and strengthen the levees on both sides of the river wherever they now exist.

Senator WASHBURN. Would it build all the levees that are required?

Captain LEACH. Yes, sir.

Senator WASHBURN. What is going to become of the other $65,000,000 which have been estimated for?

Captain LEACH. That sum will be required for the caving banks and for any other work that may be necessary in closing high-water chutes, and in case of local obstructions of navigation, taking such means as may be necessary to remove them. I mean that the sixty-five millions will control the whole river.

Senator WASHBURN. How will the seventy-five millions be expended? You propose to expend ten millions for levees; how would the other sixty-five millions be expended?

Captain LEACH. In the first place I may say that sixty-five millions is the maximum estimate of any engineer connected with the work. My own estimate would be less than half of it, and I do not think my estimate is the lowest possible. Some of the money would have to be expended to protect the banks of the river from caving.

Senator WASHBURN. How do you get at that?

Captain LEACH. By a system of revetment, mattresses of brush ballasted with stone.

The CHAIRMAN. Have not some of these mattresses caved in?

Captain LEACH. Not recently. Not since we found out how to build them. We have not lost any since we found out how to build them.

The CHAIRMAN. Then, in your opinion, the amount of money that it required to build a canal from Manchester, England, to deep water will protect the Mississippi River from top to bottom?

Captain LEACH. Fifty millions will do it handsomely.

Senator WASHBURN. Do you agree with General Comstock that so far as the improvement of navigation is concerned, that is to be accomplished more by improvements in the bottom of the river than by levees?

Captain LEACH. No. I do not agree with him in that respect. I have stated my position as definitely as I can. I believe that the

improvement is progressive, that a little improvement is better than none, and that complete improvement is best of all, and is what the people need and demand. Partial improvement may be effected by partial control. Channel works will protect the river and control it so long as it is in its natural banks. Complete improvement is possible only with complete control. That is only possible by levees.

With regard to the specific way in which levees are made useful, I may illustrate by the practice in sewer constructions. Where the river makes a sharp bend at high water when it is well out of the banks, the fall across the point is equivalent to the fall around the bend. Therefore the rate of the fall is very much greater across the point. The result is that a greater or less amount leaves the channel at right angles and flows across the point. If you try to make a junction of a branch sewer with the main at right angles you will have considerable trouble. They do it effectually by bringing the joint in at an acute angle. If water flowing squarely into a sewer will obstruct it, why would it not do the same thing in a river? There is only one way to keep it from flowing in and out of the river, and that is to build a levee. The water does harm when it comes out, and it does harm when it goes in.

The CHAIRMAN. I suppose the most important place is the middle of the levee where the water goes out and returns in the same place.

Captain LEACH. Yes, sir. I think the levee should be made to follow the convolutions of the river as closely as the nature of the ground will permit. If they could be built at a uniform distance, a mile apart the whole length of the river, the conditions would be the most perfect that could be hoped for. If that is impossible, then the next best thing is to build them as nearly at a uniform distance apart as can be done.

STATEMENT OF HENRY FLAD, C. E.

Mr. HENRY FLAD, a member of the Mississippi River Commission, appeared before the committee.

The CHAIRMAN. Have you ever considered this outlet question which has been presented?

Mr. FLAD. I used to discuss the question of outlets with Captain Eads years ago and formed an opinion in regard to it at that time.

The CHAIRMAN. What conclusions have you arrived at touching the outlet proposition?

Mr. FLAD. I am opposed to the opening of an outlet like that now proposed to be made at Lake Borgne. It would give temporary relief only.

The CHAIRMAN. Why?

Mr. FLAD. The outlet would probably silt up. If it would increase in depth and in quantity of discharge it would interfere with the efficiency of the jetties in securing a deep channel at the mouth of the South Pass.

The CHAIRMAN. So that your method would be by narrowing the channel to 3,000 or 3,500 feet and then by revetments on the banks.

Mr. FLAD. Yes, sir.

The CHAIRMAN. And levees outside of those?

Mr. FLAD. Yes, sir.

The CHAIRMAN. Wherever necessary?

Mr. FLAD. Yes, sir.

The CHAIRMAN. That you would require only for the purpose of navigation What I mean to ask is this: Do you say that the interests of navigation require levees and revetments and the narrowing of the river, throwing out of consideration the question of protecting the people from overflows?

Mr. FLAD. I believe that the improvement of navigation demands the narrowing of the river, revetment of shores and levees properly located and constructed..

The CHAIRMAN. So that if you were on the river undertaking alone to improve navigation and disregarding the people living on the banks you would still build levees?

Mr. FLAD. I would.

ADDITIONAL STATEMENT OF MAJOR B. M. HARROD.

Major HARROD. I would like to testify also about outlets, and particularly about the Lake Borgne outlet. I concur generally with the testimony which has been given here, particularly with that of Captain Leach. I speak about the Lake Borgne outlet because I am city engineer of New Orleans, and that city is very largely interested in an outlet located below there.

The Lake Borgne outlet would discharge over a tract of land about 6 miles wide into Lake Borgne. Lake Borgne has a depth of 7 or 8 feet. The distance from the river through Lake Borgne

to such deep water as you find off the mouths of the passes is some 60 miles. Although Lake Borgne is now at tide level, and the tide ebbs and flows there, that condition would immediately cease when the Lake Borgne outlet would be made, and you would then have a fall of 15 feet at high water—the height of the river above the Gulf—you would have a fall of 15 feet distributed over the 60 miles from where the Lake Borgne outlet is located to deep water in the Gulf.

That distribution of slope means inevitably the elevation of the surface of Lake Borgne. I should estimate that when the channel was built through it would amount unquestionably, in my opinion, to 5 or 6 feet. Lake Pontchartrain empties into Lake Borgne. Therefore if you raise the level at Lake Borgne you raise the level of Lake Pontchartrain.

The CHAIRMAN. Necessarily?

Major HARROD. Yes, sir. They are practically on the same level, except, perhaps, it would be fair to say that Lake Pontchartrain is 3 or 4 inches higher than Lake Borgne. If Lake Borgne is raised Lake Pontchartrain will be also. Now, sir, if Lake Pontchartrain were raised 4 or 5 feet, nineteen-twentieths of the city of New Orleans would be probably 3 or 4 or 5 feet below that water surface, and would need constant protection. When I say nineteen-twentieths I mean not value but area.

The topography of the city of New Orleans is this: It is thickly built up along the alluvial slope of the river bank, and within a distance of three-fourths of a mile from the river bank you reach practically a tidal marsh, a marsh which is overflowed in southeasterly gales. If Lake Pontchartrain be raised a foot or 2 feet, or more, it places part of the city of New Orleans that much under the surface of Lake Pontchartrain.

The CHAIRMAN. New Orleans is lower than the lake?

Major HARROD. Some portions of it are as much as 1½ feet. At present Lake Pontchartrain is 1½ feet above its natural level, from the Nita crevasse above the city of New Orleans. In its normal condition some parts of the city are 1½ feet below, and it would devolve, I suppose, on the Government to protect the city of New Orleans and generally the lake bank against overflows.

The CHAIRMAN. If an outlet were made into Lake Borgne, of course it would create a current down through that outlet. Would not that current scour out a canal through Lake Borgne to a depth and with a current which would prevent this filling up of Lake Borgne, which you suggest?

Major HARROD. I think not, sir. The bed of Lake Borgne and the bed of Lake Pontchartrain both are old sea-beds and are of hard clay mingled with shells. I do not think the river unaided would excavate anything like a sufficient channel. I think it would fill this Lake Borgne up with sediment generally, with a number of tortuous and worthless channels through it. It would become a marsh, intersected with bayous, tortuous and shallow. It would make very much such a result as has been made at the

Jump and also at Cubitt's crevasse. Cubitt's crevasse is, say thirty years old, and there is a large subdelta built out there now through which runs a number of bayous of no particular importance. The outlet at the lower end Jump, I am told, is practically unnavigable. I think luggers do not go through there at times. This is what has occurred at these places, the building up of large marshes. I should expect the same thing to happen to Lake Borgne. The elevation of the water surface is a thing that certainly will happen.

Your tide level which now extends up to within 6 or 7 miles of the Mississippi would be pushed out 60 or 70 miles to deep water in the Gulf. Motion means slope, and if it flows 60 miles before reaching deep water it means 60 miles of slope, and in Lake Borgne you are very near the head of that slope, and it would, I have no doubt, amount to several feet ultimately, or as soon as the regimen of the outlet was established.

Now I want to speak a little more about outlets. I think there is observed a very great difference in the effects of outlets in relieving flood waters. There is a marked difference between their effect of lowering the flood surface of a river accordingly as there are sudden breaks at flood stage or as there are permanent ones. I think Captain Leach testified about the relief you got from a crevasse, a sudden break which occurs when the river is in flood. That is indisputable. In the case of the Nita crevasse the effect that Captain Kingman testified to was 1½ feet. You got this local and temporary relief. I do not think that there is any reason to expect that such relief would be permanent.

STATEMENT OF H. B. RICHARDSON.

Mr. H. B. RICHARDSON, chief State engineer of Louisiana, appeared before the committee.

Senator GIBSON. How long have you been chief engineer of the State?

Mr. RICHARDSON. Since 1880.

Senator GIBSON. Will you be kind enough to state to the committee your opinion as to the proper manner to treat the river, both for navigation and for the protection of the people living in the valley, and in that statement you will discuss, of course, the jetty system, the outlet system, and the levee system?

Mr. RICHARDSON. I believe the plans of the Mississippi River Commission for the improvement of the navigation of the river are correct. I believe the bringing of the river to a somewhat uniform width must result in giving it a somewhat more uniform depth than it otherwise would have. The building of revetments for fixing the bank of the river in some one position and the building of levees along its banks for retaining its flood waters I think are of greater importance than the channel works. You have had the river improvements so fully discussed, and I so fully agree with what has been said by the engineers who have discussed it, that

I need not take up your time by saying anything more than that I generally concur and agree with them.

Senator GIBSON. What do you think would be the effect of an outlet at Lake Borgne?

Mr. RICHARDSON. I think the effect of an outlet at Lake Borgne, if it were made into a previously prepared channel at once would be similar to the effect of a crevasse, which would produce an immediate temporary and local relief to the flood conditions of the river. Its final effect I believe would be to silt up Lake Borgne as any other crevasse silts up the country in its neighborhood, or the lakes or country into which it discharges, and that such a channel could not be maintained for many years. If it were maintained it would necessarily result, in consequence of a division of the channel into two parts, in the manner which has been frequently stated here yesterday and to-day, in a deterioration of the channel below, a deterioration of both channels. If the channel through Lake Borgne were maintained the present channel of the river would be deteriorated. My belief is that the Lake Borgne channel would close before a very long time. It would result, meanwhile, in the elevation of the bed of the river below, and consequently of its flood levels below and above.

STATEMENT OF CAPT. THOMAS W. SHIELDS.

Mr. THOMAS W. SHIELDS, of Cairo, Ill., appeared before the committee.

The CHAIRMAN. What experience have you had hitherto on the Mississippi River?

Mr. SHIELDS. My experience has been from a practical standpoint altogether and actual observation; nothing from a scientific stand-point. I have been on the river for nearly twenty-five years, and during all that time I have been steam-boating between Cairo and New Orleans, commanding some of the largest steamers on the river.

The CHAIRMAN. What is that distance?

Mr. SHIELDS. Twelve hundred and fifty miles.

The CHAIRMAN. By the river?

Mr. SHIELDS. Yes, sir..

Senator GIBSON. What line of steamers?

Mr. SHIELDS. Mostly the Anchor Line. I have been on the river in all its stages, from its highest floods down to the very lowest water. I was on the river before the Mississippi River Commission was created and before it commenced its work. I listened to Captain Ernst's testimony in regard to Horse Tail Bar, for I have bivouacked there for a week at a time on a steam-boat, sparring off and going on, and I have also had a very sad experience at Plum Point, pecuniarily. These have always been great obstructions, so far as navigation is concerned, with steam-boatmen, and also Lake Providence. I believe the reason they were selected by the Commission was because they were the worst

places on the river. Horse Tail is between St. Louis and Cairo. Plum Point is about 100 miles below Cairo, and Lake Providence is still further down the river, about 75 miles above Vicksburg.

Senator GIBSON. How long were those stretches that were bad for steam-boatmen?

Mr. SHIELDS. Horse Tail was a succession of bars, probably 5 or 6 miles long. Plum Point was about the same and caused by a very large spreading of the water; the water was very wide there and there were a great many outlets and bars, and at Lake Providence there were also long reaches and very wide, and they are termed by the Commission as Plum Point and Lake Providence reaches. They are designated as reaches.

Senator GIBSON. One is estimated at 41 miles and the other at 31 miles?

Senator WASHBURN. Why do they call them reaches?

Mr. SHIELDS. I do not know except that it comprises that portion of the river that is to be improved; but that is what they call them.

The CHAIRMAN. What has been the result of the operations of the Commission?

Mr. SHIELDS. They have been very satisfactory indeed. Commencing at Horse Tail the work has been satisfactory. At Plum Point I seldom hear of steam-boats even taking soundings there at low water. I believe the lowest water they have had there for the last two or three years has been, as far as I can learn, from 11½ feet to 13 feet at the very lowest stages.

Senator GIBSON. What was it before?

Mr. SHIELDS. I have seen it at Plum Point as low as 4½ and 5 feet; at Horse Tail 3½ and 4 feet.

The CHAIRMAN. What do your steamers draw?

Mr. SHIELDS. Eleven feet, when loaded.

The CHAIRMAN. Can they go through the reaches now, loaded?

Mr. SHIELDS. Yes, sir; they could go through them in low water, but there are other reaches that have not been improved by the Government. These reaches would obstruct the steamers going through in low water. These reaches above prevent a steamer loaded to her full capacity from getting through. As steam-boatmen we believe that if the practice is carried out by the Commission they will virtually make the river so that there will be practically no low water, and the boats can go along without any fear of obstruction whatever.

The CHAIRMAN. You want them to treat the other reaches in the same way?

Mr. SHIELDS. Yes, sir.

The CHAIRMAN. Is there any navigation on the Mississippi now?

Mr. SHIELDS. Yes, sir.

The CHAIRMAN. How many steamers are running regularly on the Mississippi River?

Mr. SHIELDS. The Anchor Line, I think, has eleven steamers running. They are building one new steamer, which will be out

on the 5th of next month, at a cost of about a hundred thousand dollars. The president says that he was going to contract for two more.

The CHAIRMAN. What does one of those steamers carry?

Mr. SHIELDS. The New Orleans steamers have a capacity of about 2,000 tons. What is called the Natchez steamers have a capacity of about 1,600 tons. They tow barges in extreme low water, over the upper end of the river.

The CHAIRMAN. How many other lines do you know?

Mr. SHIELDS. The Mississippi Valley Line is one of the largest transportation lines, I presume, in the United States to-day, and has more tonnage than any other line.

The CHAIRMAN. Between what points?

Mr. SHIELDS. New Orleans and St. Louis. They use what we call tow-boats and barges; they tow six and seven and eight barges at a time, and those barges are built to carry about 2,000 tons apiece. They have have been taxed to their utmost capacity for the last twelve months in carrying grain.

The CHAIRMAN. What does it cost to carry grain from St. Louis to New Orleans?

Mr SHIELDS. There are different prices, and really I do not know what the barge rate in bulk is. The usual price now is about 15 cents a hundred, or $3 a ton on grain in sacks; that is the heavy part of the cargo. That is fifth-class freight. Other freights are higher. Bulk grain is much lower.

The CHAIRMAN. What becomes of this grain transported down the river to New Orleans?

Mr. SHIELDS. It is exported abroad.

The CHAIRMAN. Shipped direct for import?

Mr. SHIELDS. Yes, sir.

Senator GIBSON. I desire to say on this point that I received—and I expect the Senator from Missouri did—a memorial from the Chamber of Commerce of St. Louis, stating that 20 per cent. of the entire corn crop of the United States was exported by way of New Orleans.

The CHAIRMAN. What proportion of the wheat crop?

Senator GIBSON. I do not know.

The CHAIRMAN. Where is the corn exported to; Liverpool?

Mr. SHIELDS. Yes, sir; and to various other countries.

Senator WASHBURN. You do not mean 20 per cent. of the entire crop?

Senator GIBSON. I understood him to say 20 per cent. of the entire crop.

The CHAIRMAN. He is mistaken.

Senator GIBSON. Yes, sir; I think he means 20 per cent. of the entire export.

The CHAIRMAN. This is a matter which interests me. It may not interest these Mississippi River people, because they know about it. How much additional commerce is there on the Mississippi River between St. Louis and Cairo and New Orleans?

Mr. SHIELDS. Mr. Chairman, there is one line of steam-boats running from St. Louis directly through; also a barge line. There are several lines on the river from St. Louis to the tributaries; also three or four lines of steam-boats on different parts of the river from Memphis, Vicksburg, Natchez, and Bayou Sara. Then the Southern Transportation Line and Cincinnati and Memphis lines come in at Cairo from the Ohio River. All the coal that is burned in that country is transported down the Ohio River and then down the Mississippi River.

The CHAIRMAN. In barges?

Mr. SHIELDS. Yes, sir.

The CHAIRMAN. So that really there is an enormous amount of freight going down the river now?

Mr. SHIELDS. Yes, sir; we think so, and in fact we believe that the Mississippi River controls the freight rates of the United States to-day.

Senator VEST. The chairman asked you in relation to the transportation on the Mississippi River. Are not the boating interests looking up? Are you not hopeful?

Mr. SHIELDS. The business has increased in the last year from 20 to 30 per cent; this business increase not being caused by any competition, but from the development of the country, as there has been no loss of traffic on the railroads; but the railroads are taxed to their utmost capacity, and we take it that it is a natural increase. The growth of that country is greater than the increase of transportation facilities.

Senator WASHBURN. There is a very general impression that the importance of the Mississippi River has been lessening all the while.

The CHAIRMAN. That was my impression.

Senator WASHBURN. On account of railroads running east and west. In your judgment what are the facts? How does the commerce, the tonnage, on the Mississippi River, the Lower Mississippi, compare with what it was twenty years ago?

Mr. SHIELDS. There is not the tonnage on the river—that is, in steam-boats. There is double the tonnage in barges.

Senator WASHBURN. That is the same thing.

Mr. SHIELDS. There is fully double the tonnage in barge shipping. There are not as many steam-boats. There are finer and larger steam-boats to-day than there were twenty years ago.

Senator WASHBURN. It does not make any difference whether the tonnage is carried in steam-boats or barges.

Mr. SHIELDS. I believe that statistics could be furnished which would show that there is much more freight going down the river to-day than twenty years ago; a greater quantity of it.

The CHAIRMAN. By boat?

Mr. SHIELDS. Yes, sir, and barges together.

The CHAIRMAN. Notwithstanding the fact that twenty years ago there were no railroads?

Mr. SHIELDS. Yer, sir; the development of the country is such

that it requires that much more transportation facilities. There are shipped from Cairo, you might say, several hundred tons daily down the Mississippi River, besides the coal interest and aside from the railroad interest. That is down the river. The steamboat men think that steam-boating is getting back to its former days on the river. They are very hopeful of it anyhow. Statistics to that effect could be furnished very readily.

The CHAIRMAN. What is your opinion of the method adopted by the Commission; has it improved the river?

Mr. SHIELDS. I am decidedly in favor of following their policy.

The CHAIRMAN. Levees and all?

Mr. SHIELDS. Yes, sir.

The CHAIRMAN. Would you use levees?

Mr. SHIELDS. Yes, sir; that is the idea of the steamboat men generally. If you will permit me, in substantiation of what I say, I would like to read a resolution adopted by the Mississippi River Pilots' Association. I will say in explanation that there are about 150 of these men who are now engaged upon the navigation of the Mississippi River, some of them for as long as forty years, and any one knows, who knows the Mississippi River, that they are men selected with great care; thousands of lives are placed in their hands, and all the tonnage that goes down the river is in their charge. On the other hand, a great many of these pilots up to the present flood were skeptical as to whether the levees were an advantage to the Mississippi or were an improvement of the Mississippi River. With your permission I will just read from that resolution.

Senator GIBSON. They have held a meeting?

Mr. SHIELDS. Yes, sir; they held a meeting at their rooms in St. Louis on April 25 and submitted this to the convention.

The CHAIRMAN. How many were present?

Mr. SHIELDS. You might say this resolution was unanimous.

The CHAIRMAN. Do you not suppose there were just a half a dozen present?

Mr. SHIELDS. No, sir; I do not suppose you will find one in a hundred who disagrees with this. They submitted this to the convention:

Whereas the present is the only complete system of levees we have ever had between Cairo and New Orleans, thus affording for the first time (up to the time said levees gave way under the flood) an opportunity of proving the engineers were correct; and—

They were like a great many other men; they did not believe much in Government engineers; before that time they believed in practical demonstration.

Whereas we observed a greatly increased current, caused by said levees confining the surplus water to the natural channel, thereby clearly showing that this is the quickest way to get rid of the surplus water, while at the same time the friction is greater in the bottom than on the bank, in flood tide, as banks cave very little when they are full, the water acting as a support to save banks;

Resolved: First. That we indorse the levee system as proposed by the "Mississippi River Commission" as being the first part of the solution of the problem of river improvement, verifying as it does the statement in a report of one of the

engineers of the commission, viz.: "That a river that will discharge its surplus water from Cairo to the Gulf between levees in ten days when it takes one hundred days for it to reach the same through the swamps can be controlled."

Second. That as the Mississippi River in its present unimproved condition fixes the rate on transportation for 150,000 miles of railroads, we can not understand why so eloquent a plea as this fact alone makes should receive so little attention by the representatives of 60,000,000 people in Congress assembled.

From conversations I have had with many of the pilots, I know they have come to the conclusion that this season, up to the time the levees broke, that the levees were confining the water to its natural bed, thereby increasing the velocity of the current and scouring out the channel, and that some of the captains were counting the extra expense in fuel in coming up the river, meeting this flood. The current was a great deal deeper and a great deal stronger, and it necessarily took more fuel to come up the river. The impression that prevails upon the river to-day is that whenever the Government has gone on with the work they have succeeded in confining the channel and making a deep low-water channel, so that there is no trouble in navigating. I do not know of anything else.

ADDITIONAL STATEMENT OF MAJOR B. M. HARROD.

Major HARROD. Mr. Chairman, there has been some testimony given here that the gauges of the Mississippi River have been changed with a view to falsifying the records. I am on the committee of gaugers of the Mississippi, and I want to contradict that statement absolutely. There has never been a change made in a gauge that has not been recorded and printed. These gauges are officially kept up and the proper corrections are made in the publication of gauge-reading. I wish to contradict absolutely any statement to the effect that any change of gauge has ever been made without proper publication notice and correction of the record.

STATEMENT OF H. B. THOMPSON.

Mr. H. B. THOMPSON appeared before the committee.

Senator VEST. Have you heard the statement of Captain Richardson?

Mr. THOMPSON. Yes, sir. So far as the general conditions of the river and the methods of levee construction, which we have both been engaged in for some time, are concerned, I can verify his statement, and I fully agree with him in everything he has said.

Senator VEST. Have you any new matter to introduce?

Mr. THOMPSON. I hardly think so.

STATEMENT OF JOHN H. RICE.

Gen. JOHN H. RICE, of Fort Scott, Kans., appeared before the committee.

Senator GIBSON. Where do you reside?

Mr. RICE. At Fort Scott, Kans.

Senator GIBSON. You have heard this discussion of the Mississippi River. Can you not give us your view and your opportunities for acquiring knowledge?

Mr. RICE. Well, sir, my opportunities have not been very great. My business has led me to make my residence principally for the last three years at Natchez, Miss., on the river, and my business has induced me during that time to study the river very closely, and especially these overflows. I have been trying to interest, and have interested several gentlemen in the East to make an investment of money there, and I had to try to satisfy them that their property would not be totally washed away and destroyed by the overflows of the river, and that led me to investigate this river matter very closely.

I am not a civil engineer. All I know is simply from investigations I have made from that time and from observation. I am satisfied in my own mind, sir, that if the river were perfectly leveed, from what I have seen, that it would give a channel for navigation without let or hindrance from Cairo to the Gulf. There is not a mile of river, from Cairo to the Gulf, where the channel is only 3,000 feet wide or less where the water is not from 40 to 100 feet deep; and not a mile where it widens—spreads out—as it does in many places, from 5,000 to 10,000 feet wide where the water does not shallow—form sand bars—and at low water is only from 7 to 15 feet deep.

Take Natchez for instance. At the lowest stage of water last summer it was 1,961 feet at the narrowest place. I suppose the depth of the river there is not less than from 80 to 90 feet. You go down the river 8 or 10 miles to the head of Natchez Island, where it spreads out, and at low water there is only 7 to 9 feet at the most on the bar; from my observation that holds good everywhere on the river.

There has been something said about rocks. I want to say something about that. I think I read in the testimony of some witness—I do not remember who—that the gauge at Natchez was placed on a rock, that there had been a gauge on a rock, and that the bottom of the river had risen. I want to say that in my opinion the man does not live who ever saw a rock at Natchez. There is no rock there. There never was, unless it was hauled there on a steamboat or railroad. I was last week in a cut on the bluff of Natchez where the cut has gone down over 100 feet. There is no evidence of any rock anywhere. The gauges at Natchez are situated as follows: One is on a post on a small island close to bank; one on a sill of O'Brien's coal-house, and one a nail driven in an old brick wall. There is no rock there. At very low water there is a little gravel point that runs out 200 feet under the bluff and runs out into the river a little way. There are chunks of it; it is not rock, and has no firm consistency like rock. If you hit it a lick with a sledge-hammer it goes all to pieces.

I know this fact, also, in relation to the lowering of the flood tide by outlets. There is now 8 miles above Natchez what is called the Ferraday crevasse, pouring an immense amount of water into Concordia Parish. Immediately below Vidalia is another crevasse, close to town, some 3 to 4 feet deep. Down 18 or 20 miles below is the

Henderson-Ashley crevasse. There is an immense amount of water going through there; and then the crevasse at Bayou Sara, and the still larger crevasse at Morganza, and they have all been running now for some ten days or two weeks, and the water when I left Natchez, Tuesday last, was not 4 inches lower. I think that alone refutes the idea that a crevasse will lower the height of the flood surface to any considerable extent.

Senator GIBSON. What is your b usiness?

Mr. RICE. I am trying to build a railroad from Natchez to Kansas City.

Senator GIBSON. Which makes you very much interested in the prosperity of the country?

Mr. RICE. I am, sir.

Senator GIBSON. What is the judgment, so far as you can learn, of the intelligent practical men in that community about levees?

Mr. RICE. I do not know a single intelligent practical man between St. Louis and the Gulf of Mexico, in the Mississippi Valley, but who is in favor of the plan of the Mississippi Commission and in favor of levees. It is universal amongst men of intelligence and men who know anything about it; and the people in Kansas are very much interested in it. I know that in the shipment of corn from Fort Scott on the railroads that the rate of freight to-day is largely controlled by the Mississippi River. If you want to ship grain from Kansas City or Fort Scott to Liverpool by way of New York the rate of freight to New York is controlled by the freight rates on the Mississippi River.

Senator GIBSON. The farmers of Kansas, therefore, are very much interested in it?

Mr. RICE. There is not a farmer in the Mississippi Valley who has not a direct interest, in my judgment, in the improvement of the Mississippi River.

Senator GIBSON. Do they all know that?

Mr. RICE. Yes, sir; they do know it. Many of them, however, believe that a deep-water harbor on the Gulf coast would do them much more good. I had the honor of being a member of the Galveston deep-water harbor convention. I was at the last harbor meeting at Topeka, and I there made a speech in which I tried to show them that there was an harbor at New Orleans 130 miles long and 100 feet deep; that they already had deep water; but of course they were after the Galveston harbor. They have got the same interest in the Mississippi that they have in that. Their attention has not been so much drawn to it, but those whose attention has been drawn to it understand the matter.

Senator GIBSON. Are you president of this railroad which you are attempting to construct?

Mr. RICE. Yes, sir.

Senator GIBSON. Have you ever held any public position at the hands of the people of Kansas?

Mr. RICE. Well, no, sir. I had the honor to head the electoral

ticket for Mr. Blaine when he was a candidate for President. That is all.

The CHAIRMAN. That gives you a certificate of good character. [Laughter.]

Mr. RICE. Thank you, sir.

STATEMENT OF WILLIAM G. YERGER.

Mr. WILLIAM G. YERGER, attorney for the Board of Mississippi Levee Commissioners of District No. 2, of the State of Mississippi, appeared before the committee.

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Mr. YERGER. A few years ago in summer time, at low water, the Anchor Line had habitually withdrawn their best boats, whose carrying capacity is from 1,500 to 2,000 tons, and put in small stern-wheel boats for the purpose of doing their transportation business. I may also add that they did not own these boats; they chartered them. Now they ply the river with their own boats, and I do not hesitate to say in my judgment that it is the best organized transportation line I ever saw.

In my judgment it is a great mistake to suppose that their only difficulty is to navigate the Mississippi at low water. I believe the commerce of the river is greatly interfered with and the navigation of the river in a large measure impaired at flood height. It has not been a month since I made a trip from Greenville to Vicksburg on one of the very best of the Anchor Line steamers, and I know personally that she is piloted by two of the very best pilots in that line, and that both endeavored to make a landing at Jeffries, and because of the water over the bank out of the channel of the river, that boat grounded and remained there five hours and was pulled off by another vessel. Our people, of course, are primarily interested in the matter of levees for the purpose of protection, and they are an intelligent people in the main, and their thought has been directed to this matter. Since 1865 they have subjected themselves to a tax, a maximum tax of a cent a pound on cotton, and for a number of years they paid that; but from time to time it has been reduced until last year it was 30 cents a hundred, together with an ad valorem tax of 5 mills upon the value of their property for the purpose of maintaining and constructing levees.

The disaster of 1882 very greatly cast down our people. They were thoroughly demoralized and well nigh ready to abandon the levee system, but they went at it again, and I am glad to say that the disaster of 1890 will be a lesson to them.

Recently there was held a levee convention at Vicksburg, and in my whole life I have ever seen such united levee sentiment as exists in the Mississippi Valley to-day, and I believe it comes because of the increased intelligence which is being bestowed by the Government to civil authorities upon this work of navigation and protection. At times of high water, as suggested by Captain Shields, these steamers are unable to land, and in addition to that, the people are unable to get to them, and in consequence thereof your com-

merce is very much lessened, for the people can not transport their produce on these vessels at such times, and they can not get to them to transact their business.

STATEMENT OF T. G. DABNEY, Civil Engineer.

Mr. T. G. DABNEY, engineer in charge of Upper Mississippi levee district, appeared before the committee.

Mr. DABNEY. Mr. Chairman, I am the engineer in charge of the Upper Mississippi levee district, with headquarters at Clarksdale, Miss. There are two districts in our basin. It is divided into two levee districts. Colonel Yerger, who has just occupied this seat, lives in the lower district, No. 2. I am in charge of the upper district, extending from the State line southward to the lower district, and the official designation of it is the Yazoo—Mississippi delta, Mississippi district.

The CHAIRMAN. How long have you lived on the Mississippi in that country?

Mr. DABNEY. I have been engaged professionally on the Mississippi River for a large part of my time for twenty years. To properly understand and appreciate this discussion, it should be borne in mind that the channel of the Mississippi River, which without the obstructive sand-bar would be a deep trough, seated in a hard formation as it presents itself now, is a succession of deep pools and sand-hills, obstructive sand-hills across the channel. Those sand-hills, as I term them, oscillate with the rise and fall of the river. That is a matter of common observation by pilots as well as the truth which has been adduced by an examination by the River Commission. To explain my meaning, if there is a crossing with only 5½ feet of water on it at extreme low water, when the river rises 20 feet there is not 25½ feet of water on that bar, but only 15 feet. I will endeavor to explain, Mr. Chairman and Senators, what I mean by these expressions.

When the river rises it becomes very heavily charged with sediment, and when it has to encounter these wide obstructions it loses part of its energies. As it continues to rise this precipitation continues, and when it is at its maximum these bar-crests are at their maximum. When the river recedes it loses a good deal of this sediment, and as it lowers it lowers the crests of these bars. If the river was suddenly disclosed, the bed of it at extreme high water, or if it were suddenly to drop to low-water mark, there would be no movement of water; there would be no open channel; there would be dams across it at frequent intervals, by reason of the building up of these bars during the progress of the rise in the river.

Now, when the water is dispersed laterally from the channel that enervating effect increases and builds the bars up higher than they would if the water were confined within the levees. The confinement of it gives it increased energy and power to carry this matter over the crests into the pool beyond, so that the crests of these bars never rise very high during maximum flood times, and in the process of falling they would be borne away. The general effect of

that would be to approximate an equality of depth as between these bars and the pools between them. That, I believe, is the *modus operandi* by which the river obstructs itself from the dispersion of its waters, and conversely gives itself greater capacity to avoid its floods, and consequently a diminishing flood height when it is confined between levees.

Senator GIBSON. You concur in the opinion of the engineers who have expressed it, that the effect of contraction is to remove these sand-bars from the bottom of the river and to increase the velocity?

Mr. DABNEY. Yes, sir; it would diminish the height of those bars and would produce a greater uniformity or a nearer approximation of uniformity of depth than when the water runs wild over the country dissipating the energies of the river.

If I may be permitted, I would like to give some expressions on the general subject of levees, as the impression which I have is that the efficacy of levees to restrain floods is in question before this committee. The effect of this present flood has been adduced in support of the contrary view that they are not efficators. There have been expressions here from engineers who are more familiar with the matters than I am, controverting that view. I think, perhaps, it would throw additional light on the subject if I should give some of the facts that are known to myself and occurred in my own experience, in my levee district, during this flood season.

I have a frontage of 120 miles of levee. The district next below me has an extent of 60 miles, reaching from the lower end of mine to where they had their first crevasse—I mean the crevasse highest up—making a stretch of 180 miles of levee. There was one break in my front. It attained a width of 280 feet. From the head of the Yazoo Basin, on the Mississippi side, there was an extent of 180 miles of levee that was practically maintained during the last flood, and that extent of levee covered and protected about five-sixths of the entire Yazoo Basin. Less than 20 per cent. of the territory in the entire Yazoo Basin was submerged this year, and in my own levee district only about $1\frac{1}{2}$ per cent. of the country was submerged.

The greatest enemy to the maintenance of levees is the caving of the banks. I may say it is the only serious difficulty in the way of restraining the floods of the Mississippi River. It is because that considerable sections of the levee line have been annually sacrificed to the river by means of its changing its channel, caving the banks away and caving the levee away with the banks, and they have had to be renewed. That has constituted an enormous burden upon the tax-payers.

In my own levee district that evil is less than anywhere else in the delta. I have less to contend with. Therefore in the construction of my levee I could afford, if the means were available, to make permanent works on all the lines, works that I would have assurance would not have to be renewed by reason of caving banks, and I think I have exercised more care in the construction of my levees than they have in other parts of the delta, and I have now a better line of levees than elsewhere for the same extent.

I found no difficulty in building levees high enough to restrain the floods, and the only weakness exhibited under the extraordinary strain of this year was where either in old levees we had concealed weaknesses that I knew nothing about, and had not been able to detect and remove, or where the formation underneath the levee was of such a character as to permit the passage of water. In some localities there is a sub-stratum of sand a short distance beneath the surface, and in these cases I had some trouble in combating the danger, but I had no break in any place except one, where the evidence all shows there was an old long-disused wooden culvert under the levee. I knew nothing of it until since the break occurred, but the levee was abundantly strong and resisted the strain upon it.

Now I have been up and down the river a good deal. I have been employed by the Government as an attache of the Army Engineers on levees, and I have been interested professionally in the treatment of the river for a good many years and over a considerable extent of it. I have heard a witness here state that there were rocks at various points in the river at very remote periods in the past, which have since disappeared. I observed that he located some of those rocks near Myersville, in Mississippi. That place is about 40 miles from the nearest hill formation, and if rocks were there they could not have been there as permanent fixtures. They must have been deposited there in an accidental manner, because that region has several hundred feet of alluvial deposit under it. As to those rocks having since disappeared, I may mention that in many places along the river steamboats have been sunk and buried and disappeared. In other places islands have grown up and come entirely above the surface even up to high water. The channel has been, and is still, shifting continually.

STATEMENT OF HIRAM R. STEELE.

Senator GIBSON. State your residence.

Mr. STEELE. My present residence is Natchez, Miss., but my business interests are in Louisiana.

Senator GIBSON. Where is your legal domicile?

Mr. STEELE. Tensas Parish. I do not know but at present my legal residence would be at Natchez, as my family is there. I have lived on the banks of the Mississippi and in Tensas Parish for the last twenty-five years.

When the proposition was first announced that it was the duty of the Government to build levees as an aid to navigation, while I thought it was absolutely proper and necessary that the Government should build the levees, and still believe that the Government will take absolute charge of the levees some day, I could not see that it was an aid to navigation; but since the demonstrations that we have had, I am convinced that we owe the navigation of the river to-day to the levees that have been maintained by private capital.

My reason for this opinion, and I think it might be proper to explain to laymen what perhaps you do not understand, is that this is a deep river with occasional sharp peaks of sand, as stated by the

last witness. We find that these obstructions to navigation exist invariably where there have been crevasses or outlets. We find that upon closing those outlets, and in many instances where there have been no other works done, these obstructions are removed. If you could see a profile of the bed of the Mississippi—for illustration, at Natchez in extreme low water it is 90 feet deep, while at the same time the state of the water at about 15 miles below, at Natchez Islands or St. Catherine's Bar, is about 12 feet. So that you find the river is driving against a wall there over 180 feet high. These conditions extend not quite so deep as this, because this is the narrowest point in the lower river that I have any knowledge of. But I suppose there is from 40 to 80 feet all the way up.

At the mouth of the Red River the difficulty with which the Government has been dealing for I do not know how many years, ever since the settlement of New Orleans, we have two hundred and odd feet in front of New Orleans, which extends down until we get to the Passes, and there we find a mountain coming up on a profile, which appears to be a sharp peak, which absolutely closes the navigation in its natural condition; and we find a reason for it, that the defined channel is lost, water disperses, and it forms this bar very suddenly to a great extent.

* * * * * * *

Now, it is suggested that as the water is so deep below Red River that levees are unnecessary. There is every reason to believe that if the same conditions should arise at any point below Red River the same results would follow as we find at the Passes, and there is great danger if the stream is left uncontrolled that it will break away and find new outlets, find new channels. That is the tendency of a stream after it reaches the condition the Missisippi now has reached, but there is a very simple and easy manner, as has been demonstrated, and is probably the only practical power by which we can dredge out these obstructions, and that is to do it by using the river itself. That has been most thoroughly demonstrated at the jetties, notwithstanding, I think, that the testimony given here, read by a person who did not consider it closely, might lead to the impression that all the works which have been done by the River Commission are an absolute injury and the people's money thrown away.

We on the river know that it is a most magnificent success and has captured the most skeptical, even the Pilots' Association, who were unable to understand how these results were to be accomplished. I do not know of any difference of opinion among intelligent people, irrespective of politics or religion.

We used to see during the low-water season large boats tied up. We know they are now running all the time from St. Louis to New Orleans, the same large packets. It may be true that at some stages of low water they do not carry as large cargoes as at high seasons; but so far as the impression upon the public is concerned we know that the boats run and that the result has been accomplished. They are very large boats. We do not have the same impression that

some of our packets are tied up and that some of our little stern wheelers are running in their places. It is known throughout the world that we have one of the deepest harbors in the United States at New Orleans.

Now, as to one consideration before this committee, the protection from floods. I think the great difficulty we have to contend with in this country is that levees are known throughout this country as private affairs; that they are necessary to the occupation of that valley, and the first impression created upon the public mind is that we are trying to get the Government to do something for private benefit.

The CHAIRMAN. That impression does not prevail with all of us.

Mr. STEELE. We hope that impression may be overcome. If it is true (and I think the people of the United States could be thoroughly satisfied with the improvement of the navigation of the river), what Eads asserts in one of his communications to the Commission or to the committee that with the levees maintained continuously to Cairo for twenty years he would guaranty 20 feet of water at extreme low water, and at the end of ten years the levee would not be required—that would be the most economical investment that could be made of the people's money.

There is a feature of this question, however, that I think would authorize you to take charge of this system aside from the question of navigation purely and without being called upon to violate the prohibition which we have had in our recent river and harbor bills, and that is that it is an interstate matter.

Now, I live in the northern district of Louisiana. We are not overflowed by the water that runs from our own banks. The water that overflows our district of country enters the country in Arkansas, and we are prohibited by the Constitution from making contracts with the State of Arkansas, and for the last series of years we have, by courtesy, with our own money spent over $100,000 in building levees. We are taxing ourselves to the utmost capacity to build levees in Arkansas. We have no police control. We have no power of supervision of these levees. We find that we can not exist without them. We have a most magnificent territory.

There are over twenty parishes that are affected there, and by courtesy we are going into Arkansas and building levees where we can not protect them or prevent people from riding on them. It is a very small part of Arkansas that is interested. It is only two counties below the mouth of the Arkansas River. The balance of the State has no interest in this matter. This little corner is not sufficient to shape legislation in Arkansas. It is only that they do not care that they allow us to build the levees there. They had an idea some years ago that it would be just as well to let the water run down on Louisiana. This year they have got one of our levees up there. The good people have denounced it, but it does not excite any interest in Arkansas. We have been discouraged from that source, causing indignation almost enough to start a war. This levee system is a national system. It requires a sort of action be-

tween eight States and districts and counties. Our States are not all alluvial land. Our legislatures are divided. We have to have special legislation for these districts, and it is not always certain that we can carry our legislatures on these matters.

It is certainly a Federal question from the very nature of it. Another feature of it which seems to me ought to enable the Commission to say that it is not illegal to build levees, is the fact that the immense commerce of this whole Southwest is interrupted. I do not know that you gentlemen are aware that to-day the Illinois Central Railroad, which is just building a bridge costing $2,000,000 at Cairo, can not run a train into New Orleans, their terminal, and has not for thirty days.

The immense Texas Pacific is cut in two. The Southern Pacific, extending from New Orleans to San Francisco, has not run a train for a long time, and is cut squarely in two by the breakage of these levees. Now the mail service is entirely stopped there.

This immense commerce and this road, which we properly know is the Mississippi Valley Road, runs through the Louisville district from Mississippi to New Orleans, and is the connecting link of the southern system. It has absolutely had more traffic in the height of the season in handling the cotton crop of that country than it could carry with a single track. The business upon the railroads does not seem to have diminished the business upon the river. The business upon the river has been increasing. The officers of the Anchor Line stated within the last thirty days that the last twelve months has been the most successful in their history, not only in freights, but that they had had a large amount of passenger business. Since these improvements they told me that they had stopped insuring their boats; and for this committee and the public who read of this investigation to get the impression that the people's money is being thrown away in improvements on the river is a great wrong. The improvements have had a most brilliant and magnificent success. They are in charge of a corps of men of which the nation has a right to be proud, and notwithstanding all the slanderous reports no one has ever dared to say that one dollar has ever been stolen or misappropriated. We ask that the people of the whole country may sustain them. We do not know what they are going to do, but we are willing to trust them. Let them handle this matter and we know that success will follow.

STATEMENT OF T. W. STRINGER (Colored).

Mr. T. W. STRINGER, of Vicksburg, appeared before the committee.

The CHAIRMAN. Where do you live?

Mr. STRINGER. Vicksburg. I have lived there continuously since 1865, just after the conclusion of the war, when they were throwing no more marbles at each other.

The CHAIRMAN. There was a gentleman who appeared here the other day, representing the colored people of the Mississippi bottoms, as he stated, who said that this levee business was a scheme of the

Bourbons, meaning, I suppose, a scheme of Senator Gibson and others [laughter], and he said that the colored people up and down those bottoms were opposed to the levee system; that they were taxed and were furnished rations and things of that kind, but that they were compelled to pay twice what they were reasonably worth when there was a chance to work, and that the poor people or the colored people up and down the river were almost entirely united against the levee system. Now what have you to say about that?

Mr. STRINGER. I do not know who he was. I have no hesitancy in saying that he did not represent us in the delta at all.

The CHAIRMAN. He did not represent the working-men?

Mr. STRINGER. No, sir. We are in favor of the levee system as represented here to-day, and expect our friends to keep it up in that manner. The reason is obvious. Without that we can not subsist down there; there is no use talking about it. We have the cotton to make. Take away the protection of the levees when our lands are overflowed and we starve to death. Within these few years we have been buying little homes. We are buying them in the delta; we would not go anywhere else. We are adapted to making cotton, and we have got just enough good common sense to go where we can live, and they are coming in from Georgia, North Carolina, South Carolina, and from all around into that belt, and ere long you may call that Africa [laughter], and of course we ask our friends to protect us in our endeavors to make ourselves men.

Senator WASHBURN. Whom do you consider your friends?

Mr. STRINGER. We know who our friends are. [Laughter.]

Senator GIBSON. Have you anything further to say?

Mr. STRINGER. Nothing more than we indorse the idea as advanced by the engineers in deepening the bed of the river. We would not wish it to be otherwise, because we are going to raise cotton.

Senator GIBSON. How long have you lived in the Mississippi country?

Mr. STRINGER. I went to Mississippi in 1833, and have been in that country and know all about it from beginning to end. There is one thing which is apparent to all, that if you keep your water up here we will have no trouble down there. [Laughter.]

Senator GIBSON. Are there many colored people going into the cotton country?

Mr. STRINGER. I suppose there must be twenty thousand going in there this year.

Senator GIBSON. Are they buying their own homes?

Mr. STRINGER. Yes, sir. Last year some 40,000 acres of land passed into the hands of colored men, and they are preparing, as I say, to Africanize that delta. We are adapted to the products of that country and only want a few white friends to engineer it.

The committee report in submitting to the United States Senate Committee on Commerce, the memorial of colored citizens and Republicans of the Mississippi Valley to the President and Congress of the United States.

Mr. Chairman and gentlemen of the committee, in appearing before you in the interest of the Mississippi Valley, we have premised from your inquiries that the chief point at issue is why the Government should take steps to control and restrain the floods of the Mississippi River independent and apart from the relief to be afforded us.

It is the great receptacle from the water-sheds of all the States lying west of the Rocky Mountains, comprising about three-quarters of the territory of the United States, and as the forests of this vast area are annually encroached upon by the advancing tide of civilization, its surplus waters are more certainly and rapidly transmitted to the Gulf through the medium of the Mississippi River.

Such is the magnitude of its service, that it is recorded by historian, poet, and muse as the Father of Waters.

We have no means through which to more thoroughly comprehend its national character than the history of the late war, and a contemplation of the blood and treasure expended in restoring to the nation this *greatest highway* from its heart to the sea, and the almost unchecked success to our arms after this great key was recovered

On the banks of the Mississippi River and its innumerable tributaries are situated great marts of trade for collecting and distributing the products of the farmer, the miner, and artisan. The relations of the Mississippi River to these great factors of the nation's progress and prosperity are similar to that of the spinal marrow to the human system. The framers of our Constitution seemed to fully realize that it would require the combined skill and intellectual power of the nation, exercised in its highest legislative capacity, to successfully stimulate and develop the intricate affairs of commerce, which is the prime factor in denoting the highest attainments of civilization.

From Cairo, Ill., southward to the sea the Mississippi in its tortuous course traverses a scope of country nearly 1,200 miles in extent, known as the Mississippi Valley, comprising the basins of the St. Francis, the Yazoo Delta, the Red River Basin, and the delta of the Mississippi.

Such is the aggregation of its waters flowing through this territory that it is termed an inland sea, which the advancement of engineering science has proven to be capable of affording safe and easy navigation for the largest of our merchant marine at all seasons of the year, provided the powers and duties of Congress specially delegated by the Constitution, section 8, article 3, be properly exercised to control and direct its improvement. At the head of this great valley the Mississippi enters an alluvial bed which it has doubtless been building for ages from its deposits.

Experience and scientific research have demonstrated that the greatest agency available for its improvement is its own current. The researches of these eminent engineers Humphrey and Abbott

(chapter on basin Mississippi River, page 85, marginal note "Beds of swamp rivers") demonstrates that the bed or bottom of our alluvial rivers are composed of a blue clay, which is not affected by the general flow. Consequently we may reasonably assume that by a proper application of the principles so fully and successfully illustrated by that veteran engineer Captain James B. Eads in deepening the mouth of the Mississippi, that any part of it, by proper confinement and direction of its flow, may be made to scour its channel to the depth of the blue clay strata, adapted by nature as the bottom of our alluvial rivers.

Observations and the reports of our present engineers will show that wherever the channel is reasonably restricted in width by its natural banks, it has sufficient depth for safe navigation. But wherever from the action of floods, caving banks, and other causes it becomes unduly widened and the course of its current divided into different channels, it deposits shoals and impediments to navigation. The succession of basins lying on either side of this great stream in the district of its alluvial formation contains about 20,000,000 acres of land possessing a most fertile and inexhaustible soil which is subject to destructive floods, occuring in a greater or less degree annually, which endanger and destroy human life, and lay waste to millions of property.

As to the necessity of Government protection and the value to be contributed to the general commerce and exports of the nation that will be derived therefrom, we submit the following memorial from the colored citizens and Republicans of the Mississippi Valley:

To the President and Congress of the United States:

We, the undersigned citizens of the Mississippi Valley, respectfully represent that there are about 20,000,000 acres of land, having a most fertile and inexhaustible soil, lying on either side of the Mississippi River, which has been, is now, and will continue to be, subject to destructive floods, occurring in a greater or less degree annually, but which might be made the equal of any, if not the most valuable section of the United States, in point of productions, and possibly superior to any in the known world, by the action of the Federal Government, provided this subject is properly considered and appropriate legislation provided for its redemption.

Much has been written and spoken for and against the teasibility or practicability of redeeming this important section of country from the visitation of these annual overflows, and, owing to the imperfect data that has heretofore been available upon which to predicate correct conclusions, the public mind is still undecided as to the practicability, or otherwise, of protecting this section from floods.

A brief statement of the facts upon which the many conflicting ideas have been based is perhaps necessary, in order to have anything like a correct appreciation of the reasons for the many diverse opinions which now exist upon this important subject

In the first place, it is necessary to state that up to this time there has been no plan of action which was supported by any power adequate to supply. either the thought or means necessary to comprehend, elaborate, or carry out any plan on a sufficiently large scale to even give promise of any great success.

It is to be remembered that not even the States adjacent to the Mississippi River, as a rule, have taken action in their capacity as States, but the efforts that have been made toward protection from overflow have been made by the various river counties, at most by a few counties organized into districts under legislative enactment by the several States. And even in these districts, where so organized, they have been made up of counties that would suffer by an overflow of a particular section or locality, and have not been extensive enough to protect all of any of the three or four great basins which lie between Cairo and New Orleans, first upon one and then upon the other side of the river.

It will be manifest that it was unreasonable to expect anything but failure in such disconnected and limited organizations, which in the main have been without means, except such small sums as could be gathered from taxation of a district which, owing to the fact that it has been subject to these destructive floods, is up to this time but sparsely settled. Enough has been accomplished, however, in this very disconnected and limited manner to prove beyond question the feasibility and practicability of redeeming this vast and fertile section at a cost which is very insignificant in comparison to its value to the nation when reclaimed.

Owing to the fact that the portion of the river country subject to overflow lies partly in as many as four or five States, and that owing to the further fact that in none of these States is there a large enough section of such State subject to overflow to give a controlling power to the legislature, it is almost out of the question to hope that, for at least many years to come, the strength and power of the States can be enlisted in any intelligent system of legislation on this most important matter.

It may be truly said that this is strictly an interstate question, the more so when it is taken into consideration that the water of this great river is derived from the following States and Territories, viz: New York, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Tennessee, Kentucky, Ohio, Indiana, Wisconsin, Minnesota, Dakota, Montana, Wyoming, Colorado, Nebraska, Iowa, Kansas, Missouri, New Mexico, Indian Territory, and Arkansas.

The framers of the Constitution very wisely reserved to the Federal Government the treatment of all such questions, for the simple reason that whatever concerned several states was primarily the concern of all the States. Believing, as we do, that this great subject comes within the province of national legislation, and further believing that when this fact is realized by the people of the United States, this vast country can be redeemed, as already stated, at a comparatively insignificant cost, through a system of dikes or levees, we earnestly request your attention to this subject as a matter that concerns the people of the United States at large, and as of vital interest to the colored race.

It is peculiarly in this section that the colored people of the United States can, with reasonable chance of success, make for themselves homes, and become an independent and self-sustaining population of the country.

* * * * * * *

During the present year, however, we have had a recurrence of the flood of 1882, with all its disastrous effects, except as the country, in the primitive way heretofore mentioned, has been protected by the present levees. But enough has been shown to make it an absolutely demonstrable fact that, with wise legislation on the part of Congress, which would establish a system of levee work extending over half a dozen years or more, with a moderate appropriation of, say $5,000,000 to $7,000,000, to be expended annually, the whole of this vast section of country could, through a system of levees, be made almost, if not quite absolutely secure from overflow. And after this system of levees is constructed they could be maintained at a comparatively insignificant cost to the Government.

There is no denying the fact that the confinement of the water within given limits would contribute immensely toward the maintenance of the unobstructed navigation of the river through the deepening of its channel.

In addition to all the foregoing considerations, it may be stated that the annual products of this section of country, which would be produced mainly by the labor of the colored race, would contribute an aggregate sum of nearly $1,000,000,000 per annum to the nation's wealth. This section would become their home, in a large measure, and would remove much of the supposed threatened friction between the races, about which so much has recently been said; and when that race is once in possession of homes of their own, from which so large a contribution to the national wealth annually flows, it is believed that they would no longer be objectionable to the people of any section of the Union, and that if there still should linger in the minds of any portion of the community a prejudice, the very independence of the colored people that would thus be brought about would be sufficient to, in the end, remove such objections and render the race independent and no longer a subject of public consideration any more than would be any other portion of the community.

In view of all these facts, we again earnestly entreat the Congress of the United States to take this matter into consideration and adopt such wise legislation as will bestow upon our people, and especially upon the colored race, the protection

which would bring to us such blessings and benefits as we confidently believe would result.

We hereby appoint and constitute the following committee as our representatives to lay this matter before the President and Congress of the United States forthwith:

W. H. Allen.
L. A. Bell.
A. T. Wimberly.
Peter Mitchell.
T. M. Broadwaters.
Geo. W. Butler.
John Scales.
Frank Hawkins.
W. H. Smith.
Isaiah T. Montgomery.
G. W. Gilliam.
G. W. Gayles.
W. E. Mollison.
A. J. Oakes.
W. W. Cox.
T. W. Springer.
J. S. Pratt.
A. P. Pollard.

And especially request our Representatives in Washington to render them all the assistance in their power.

Very respectfully submitted this 28th day of April, 1890.

L. A. Bell.
Jas. A. Scott.
G. W. Gilliam.
E. H. Humphrey.
G. W. Gayles.
J. E. Ousley.
J. H. Bufford.
L. C. Reynolds.
A. G. Pearce.
W. H. Smith.
Gilbert Horton.
W. E. Mollison.
Henry Scott.
Wesley Crayton.
Thos. Bell.
A. J. Oakes.
Geo. W. Butler.
D. J. Foreman.
Henry Hall.
John Scales.
Frank Hawkins.
Austin Bell.
W. H. Smith,
Henry Avant.
W. H. Allen.
Geo. H. Oliver.
A. C. Jackson.
I. T. Montgomery.
F. M. Broadwaters.
L. C. Moore.
Peter Mitchell,
Anderson Levy.
B. F. Garrett.
S. B. Blackwell.
N. A. Anderson.
T. W. Stringer.
Dr. James Porter.
S. B. Brooks.
W. W. Cox.
Geo. Cox.
John Reed.
B. F. Booth.
J. S. Pratt.
A. P. Pollard,
And many others.

Presuming that the investigations conducted by your committee have demonstrated the necessity of protection and development of this great valley coincident with the improvement of navigation, we will now briefly refer to the most approved means to be employed. The chief plans now under consideration seem to be (1) the reservoir system, (2) the outlet system, and (3) the levee system.

Here again we have recourse to the exhaustive researches of Humphrey and Abbott, under the heading of "Analysis of Plans for Protection." Pages 381 to 386 show conclusively that the system of reservoirs, while admirable in conception, owing to natural physical conditions are utterly impracticable as a means of preventing overflow.

The levee system (see Humphrey and Abbott, pages 150 to 167) seems to have been the general mode adopted for protection since the earliest settlement of the valley.

You will notice that every step of their improvement has marked a corresponding growth of commerce and material development. Humphrey and Abbott undoubtedly favored them as perfectly practicable and the only means for preventing overflow.

The engineers of the River Commission have not only sustained that conclusion, but have also shown that improvements of the Mississippi channel can not be perfected and maintained without the levee system.

Being natives of the valley and active participants in the building of levees, and close observers of floods locally, we are practically familiar with many points disclosed by the testimony of the Commission, which are also attested by Humphrey and Abbott, viz., "That overflow waters returning to the river occasion an excess of flood height at and near the point of their return, and materially prolongs the duration of floods."

We have shared the very natural opinion that the confinement of the river to its bed during floods would tend largely to raise its flood height. Experence, however, has shown this opinion in a great measure to be erroneous. In all localities where excessive flood heights have taken place local causes were apparent.

This system has been brought to its present stage by taxation, as stated in our memorial, at a cost of from $12,000,000 to $15,000,000, only $3,000,000 of which was paid by the United States. Our constituents are the chief producers in the districts affected by the levee taxes.

Therefore the raising of this enormous sum has drawn heavily upon their substance, and will continue to do so until practical relief is afforded.

We have reliable data of a community of colored people that came into existence three years ago in a wild and thickly wooded district of Bolivar County by purchases, which now aggregate about 5,000 acres. The second year their levee taxes amounted to $300, the third year at present rates they will amount to about $1,200 or $1,500, and if no change occurs, will increase at the rate of $600 annually till its maximum is reached.

We would murmur but little at this great burden if it was adequate to protect, and the end could be seen.

You gentlemen can not realize the harrowing feeling of doubt and alarm that linger over communities living miles away from the high lands and water-courses during the flood stages of the Mississippi River.

We believe that our cause is a just one, and will commend itself to all parties. But we have been encouraged to place our case before a Republican administration from the knowledge of the facts; that it is the party of progress and development; that it is fully identified as the author and finisher of every era that marks the unparalleled advancement of this great nation.

Very respectfully submitted,

THOS. W. STRINGER,
ISAIAH T. MONTGOMERY,
A. T. WIMBERLY,
Subcommittee.

The CHAIRMAN. Who prepared that?

Mr. MONTGOMERY. That is the work of our committee.

The CHAIRMAN. Are you a property owner?

Mr. MONTGOMERY. Yes, sir.

The CHAIRMAN. To what extent?

Mr. MONTGOMERY. Myself and cousin own 840 acres.

The CHAIRMAN. Do you raise cotton?

Mr MONTGOMERY. Well, we have just moved into a new community. We have not gotten well to raising cotton yet. We are just clearing the land. We can not do much at raising cotton in three years. We only have about 150 acres in cultivation.

Senator GIBSON. Were you born down there?

Mr. MONTGOMERY. I was born on the Davis Bend, and have lived on the river all my life.

Senator GIBSON. Are you the son of Mr. Montgomery who bought Mr. Davis' place?

Mr. MONTGOMERY. Yes, sir.

Senator GIBSON. Were you sent to school and educated?

Mr. MONTGOMERY. I never went to school.

Senator GIBSON. Did you compose the paper you have just read?

Mr. MONTGOMERY. I just finished it up. I have not had a chance to transfer it to ink. We thought our committee would be called in the morning, and we did not expect to report before to-morrow.

MISSISSIPPI RIVER.

Extracts from a speech of Hon. T. C. Catchings, delivered in the House of Representatives on the 22d ultimo.

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Discussion hitherto has been largely confined to the consideration of the effect which the rectification and control of the river might have upon the fortunes of those who dwell in its lower valley by securing to them immunity from the blighting embrace of the angry waters which periodically, with unrestrained fury, rush savagely down to the sea.

With some, the fact that this immunity from disaster might result, has been regarded as proof that the work is but local in scope and effect; while with others, I fear, this fact has been accepted as furnishing a conclusive reason why it should not be undertaken by the General Government at all.

If nothing more than the protection of the Mississippi Valley from desolating floods should be achieved, so large a community would be relieved and the wealth of the country would be so vastly augmented that the very magnitude of the result effected would suffice to divest it of all local characteristics and stamp it as a work of the highest national concern.

The Mississippi Delta alone extends across 8½ degrees of latitude, stretching from 29° to 38° 30′ north, being about 600 miles long and averaging about 60 in width.

It embraces about 40,000 square miles, of which at least 36,000, or 23,000,000 of acres, can be reclaimed and placed in cultivation.

A moderate estimate would give at least 6,000,000 acres of sugar lands, 15,000,000 of cotton lands, and 2,000,000 of corn lands.

These lands are more fertile than those of the valley of the Nile, which by the richness of its soil was the granary of the East, and became the seat of ancient civilization and the heart of one of the mightiest systems of government the world has ever known. The value of these lands when reclaimed from overflow would easily reach $30 per acre, or a total of $690,000,000. But stupendous as would be the result of this reclamation of the lowlands of the Mississippi Valley, it by no

means furnishes the sole standard by which to measure the benefits to the American people which would come hand in hand with the restraint, control, and discipline of this mightiest of navigable rivers.

* * * * * * *

The Mississippi and its navigable tributaries constitute a system which embraces not less than 14,000 miles of water way. They intersect, and when suitably improved will furnish facilities for transportation to, almost every part of the great agricultural region which extends from the Gulf of Mexico to the Lakes, and from the Alleghany to the Rocky Mountains, comprising an area of about 3,000,000 square miles, which is about two-thirds of the whole area of the United States.

The Mississippi Basin proper contains 1,257,545 square miles, according to Walker's Statistical Atlas, but Foster, in his work on the valley, estimates the area drained and benefitted by this great water-way system to be 2,000,000.

When this valley, as in accordance with a just popular demand it must soon be, is connected by way of the Illinois River with the great lakes at Chicago, the value of the Mississippi as a highway of commerce will be so multiplied as to be absolutely beyond computation.

The multiplication of routes of transportation, the greater profits from all agricultural and industrial pursuits, the growth of centers of population which would follow this connection of the lakes and the Mississippi River would add untold millions to the wealth of the country.

It is the part of wisdom to prepare this river for the mighty work which the near future is certain to impose upon it, and every consideration, whether utilitarian or sentimental, demands for it broad and generous treatment.

Even in its present unimproved condition, and competing, as it does, with the elaborate railway systems which penetrate and intersect its valley and often follow its actual borders, the river is the vehicle for the transportation of a prodigious quantity of merchandise and agricultural products.

In 1886 the Western farmers shipped by it, via the city of New Orleans, 743,439 bushels of grain, and in 1887 3,973,737, there being in a single year an increase of 3,230,298 bushels. Stated in tons, this makes in 1886 302,870, and in 1887 396,060.

From January 1 to July 1, 1887, it carried by barges of package freight 35,597 tons, and of bulk freight 203,873 tons.

By steamboats during the same period it carried of package freight 73,525 tons, making a total of 312,995 tons.

I have no figures since 1887, and none at all showing the amount of up-freight, though it was undoubtedly very large.

Indeed, a very significant fact in connection with the commerce upon the river is the marvelous growth of shipments designed for various points in the Mississippi Valley from New York and the East by the Atlantic Ocean to New Orleans and thence up the river by barges and steamboats.

* * * * * * *

Although I have shown that, even in its present condition, a prodigious commerce is carried on upon the river, yet gentlemen who have not investigated the subject will be, I am sure, amazed at the sum total of its value.

This can best be appreciated by comparing it with that which passes through the Sault Ste. Marie Canal, a commercial gateway upon the Great Lakes whose greatness and importance we all boastfully proclaim. The convention which assembled at Superior, Wis., in August, 1889, to devise measures to insure the speedy completion of the new lock in process of construction, estimated the value of shipments through the canal in 1889 to be $83,732,527.15.

The value of shipments upon the Mississippi River to and from the port of New Orleans alone in the year 1887 was $98,591,781, or $14,859,254.85 in exceess of that passing through the Sault Ste. Marie Canal in 1889.

It is a very moderate estimate to say that the total commerce upon the river was as much as $250,000,000. Indeed, a very much higher estimate is placed by Capt. J. W. Bryant, for many years the river statistician of the New Orleans *Times-Democrat*, who is a practical steamboat man, and thoroughly familiar with the subject.

But this is a bagatelle to what the business of the river will be when the thousands in the valley shall become millions, when the hamlets shall become cities, and when our trade with South American countries shall have been developed as it must very soon be.

* * * * * * *

About 3 miles above the Head of the Passes, about twenty-seven years ago, a crevasse occurred which is known as Cubitt's Gap. It was caused by a small canal between the river and the Gulf, used by fishermen. The distance between the two was less than 1,000 feet, and the difference in the surface height of the river and that of the Gulf was a little over 3 feet. The fall was at first about 15 feet per mile, and in a few years the crevasse was over 2,000 feet wide and 100 feet deep where the bank had formerly stood.

As soon as the water passed through, its velocity was gradually checked and the sediment was deposited in a fan-shaped area of 20 or 30 square miles. Islands and shoals were built up, which subdivided the volume into innumerable bayous and small channels, none of them having a greater depth than 5 or 6 feet; and each overflow builds up the islands and diminishes these outlets more and more; in a few years, by this process, the gap will be entirely closed.

Fifty years ago another crevasse, called the "Jump," occurred 21 miles above the Head of the Passes. A similar filling up resulted, forming an immense subdelta, upon which there are now large forests and rice plantations.

Innumerable bayous permeate this subdelta formation, no one having at its mouth more than 2 feet of depth. There are well-defined traces of similar outlets, long since closed up, at Bayou Terre au Bœuf, within 3 miles of the proposed Lake Borgne outlet, and at Kennerville, just above New Orleans, through Bayous Metairie and Gentilly.

Such would undoubtedly be the fate of an outlet, should one be made, at Lake Borgne. The lake is small and shallow, having a depth of from 5 to 10 feet, and the immense amount of sediment carried by the flood waters of the Mississippi would soon fill it up, doing immense damage to surrounding property and the fishing industries on the Mississippi Sound. In a few years the outlet would consist only of a few shallow and tortuous bayous, and eventually it would be a thing of the past.

In the meantime, however, while utterly failing to effect any reduction of the flood height, it would have caused extensive shoaling of the river channel below it, thus inflicting disaster and obstructing navigation, without making the slightest compensation therefor.

If any gentleman desires further evidence of the effect which this proposed outlet would produce, I invite his attention to the charts of the lower river, just published by the Coast and Geodetic Survey, upon which we will see definitely marked not only the shoaling of the river below the "Jump" and "Coteet's Gap" (the two outlets before referred to), but the immense deposits by which the river has practically closed them up.

* * * * * * *

Leaving entirely out of consideration the navigable character of the river and the business carried on upon it, the injury to its postal service and to this enormous railway interstate commerce is of such magnitude as to command public attention, and make it the high and imperative duty of the nation to prevent its recurrence in the future.

Having now shown that the floods can be restrained by means of levees, and that they can not be by any other means, and that the interests involved and the beneficial results to be achieved are of such character as to demand governmental aid, it is but proper that the cost should be shown to be within the value of the benefits to be realized.

I wish at this point to correct an impression which seems to prevail that the levees along the river have been chiefly constructed by the Government. There are now 1,100 miles of levees, and the Government has only expended $3,018,601.50. This statement will suffice to show how insignificant a part of the burden has been assumed by the nation. Since 1866 the State and levee districts of Louisiana have expended $15,255,327.13; since 1882 the Mississippi levee districts have expended $3,098,745.74; and Arkansas has expended $340,417.

This does not take into account the extensive levee work done many years ago, of which a very large part in a more or less available state survived the neglect and ravages of the war period.

It will thus be seen that no people in the world have taxed themseves to such an enormous degree as have these inhabitants of the valley. And notwithstanding the perpetual and gigantic struggle, they have steadily gone forward felling the forests, opening up lands for cultivation, building up villages and cities; and by their cotton and sugar and other products they have added enormously to the wealth of the nation. Nor have they failed to make substantial progress in their

efforts to shut out the floods of the mighty river. "In 1882 the total number of crevasses in the levees was 284, aggregating 56.09 miles in width; in 1883 the number of crevasses was 224, with an aggregate width of 34.1 miles; in 1885 the crevasses numbered 204, aggregating 10.64 miles in width." These crevasses resulted in a general overflow of the Mississippi Delta.

In the present flood, which in height exceeded and in duration equaled any of which we have record, the total number of crevasses in the whole 1,100 miles of levees was but 23, aggregating but 4¼ miles in width; and notwithstanding the sensational accounts to the contrary, fully 80 per cent. of the alluvial basin has enjoyed absolute immunity from the floods.

Without these levees the entire basin, excepting possibly a few high ridges of very limited area, would be absolutely uninhabitable. On May 1 of this year a convention was held at Vicksburg, composed of delegates from the States of Louisiana, Mississippi, Arkansas, Missouri, Kentucky, Illinois, and Tennessee, which was the equal in intelligence, ability, wealth, courage, and lofty purpose of any which ever assembled in this country.

Among these delegates the sentiment was universal that floods could be prevented by levees and by levees only.

This sentiment was concurred in by a splendid corps of engineers present and participating in the proceedings, and by the Mississippi and Ohio River Pilot Society, which, in the interest of navigation alone, it emphatically affirmed, by a series of resolutions, presented by it without suggestion or solicitation.

There is absolutely but one opinion among those interested in the river and having practical knowledge of its history and characteristics.

This convention and the engineers attending it estimated that $10,000,000 from the Federal Treasury, added to what the States and the levee districts would contribute, would be sufficient to build levees of such dimensions and strength as are needed to forever control and restrain the floods.

What an insignificant sum compared to the enormous benefits to be attained!

The investment of that sum would give you an improved river, which for purposes of commerce is without a rival on the face of the globe; it would enable the farmers of the West to annually save such portion of their earnings as would in a few years make hard times a chapter of ancient history; it would relieve from disastrous interruption the great overland interstate commerce; it would give safety to the postal service; it would reclaim an empire richer than any for which the nations of Europe have so freely poured out their blood and treasure; and last, but not least, it would bring joy and peace and content and plenty to millions of American citizens.

What other nation is there upon the face of the earth that would not, without hesitation, expend one hundred times this sum if needed to obtain such a magnificent and glittering prize? We have by our levees, built almost entirely with our own means, given the facilities for the development of an enormous commerce which without them could not have existed; we have made possible the wide extension of the postal service; we have added untold millions to the national wealth; we have built up markets for the transaction of business with all the States of the Union.

The work needed to effect the perfect accomplishment of the end we are seeking to reach and its permanent maintenance can not be successfully done unless the nation does it.

The States are forbidden by the Constitution from making compacts and agreements among themselves. What they do, therefore, can not be done in a perfect, systematic, and scientific manner.

Unless placed under one supreme control levees can not be scientifically located and constructed.

If there be any one thing more national than all others, it is this great and noble stream, no matter from what standpoint we contemplate it.

REPORT OF ENGINEERS.

VICKSBURG, MISS., April 30, 1890.

To the Committee on Resolutions of the Mississippi Improvement and Levee Convention:

Your committee, to whom was assigned the duty of preparing a statement on the subject of levees, beg leave to submit the following:

The testimony of all engineers familiar with the subject is, that there is no engineering difficulty in the way of restraining the floods of the Mississippi River through the agency of levees, and that this is the only agency through which that object can be accomplished. The levees, as they existed at the beginning of the recent flood, were admittedly too weak generally, in height and width, to stand an extraordinary high water, as was recognized and affirmed by all Levee Engineers.

The fundamental defect in the present system of levee building is that they have not been designed and constructed on engineering principles, in the most thorough manner, with the sole view to certain efficiency, as is the case in all other classes of engineering work; but it has always been a mere question of doing the best that could be done with an insufficient amount of money.

The great desideratum has been to pile up as much dirt as possible in the cheapest possible way, so as to cover the greatest extent of territory with the highest bank of earth attainable with the means at hand. This consideration has precluded such treatment of the foundations as the character and service of the structures demanded, to which deficiency is attributed much of their failure to successfully resist the extraordinary pressure of this flood at various points. The disasters from the recent flood have been exaggerated and magnified beyond their true proportions, by the sensational treatment which the subject has received, and which has tended to shake confidence in the efficiency of the levee system.

In confirmation of this, attention is invited to the following facts: In 1882 the total number of crevasses in the levees was 284, aggregating 56.09 miles in width; in 1883 the number of crevasses was 224, with an aggregate width of 34.1 miles; in 1884 the crevasses numbered 204, aggregating 10.64 miles in width.

The result of crevasses enumerated during these three years was a general overflow of the Mississippi Delta. In the present flood, the dangers of which are nearly passed, the crevasses which have occurred number 23, aggregating about four and one-quarter miles

in width, in a total length of 1,100 miles of levees, or less than one-half of one per cent. of the total line of levees, notwithstanding that the present flood has exceeded those of the three years cited in the height attained at Memphis and all points below, and has not been exceeded in duration. This excess of height was, at Memphis 00.5 feet, at Helena 00.6 feet, at Sunflower Landing 1.2 feet, at Arkansas City 2.3 feet, at Greenville 1.7 feet, at Providence 3.1 feet, at Vicksburg 00.1 foot, at Natchez 00.8 feet, and at New Orleans 00.5 feet. The general result has been a large measure of protection afforded by the levees this year, notwithstanding the extraordinary character of the flood, which has never been enjoyed during previous high waters of considerable magnitude.

For example, in the Yazoo Basin between 80 and 85 per cent. of its area is protected from overflow, there being only one crevasse of 280 feet in width, affecting a very small area, in 180 miles of levee extending from the upper extremity southward. There were other crevasses on this front below this locality. On the Tensas front are two reaches of continuous levee, being respectively 81 and 125 miles in length. The right bank below Red River has 180 miles of continuous unbroken levee, and the left bank has 200 miles with only one break. Of the territory dependent upon the last-named levees, 75 per cent. has been protected. The percentages of areas protected as above noted embrace all classes of lands subject to overflow; as the lands sought for cultivation are the more elevated portions, the percentage of their area protected is much greater.

From our knowledge of this subject we now feel justified in declaring that very great progress has been made during the past five years in the construction of a complete levee system by the joint efforts of the General Government and the riparian States; and also that the experience of the present flood has strongly added to our conviction that such a system presents the only solution of the protection of the alluvial valley from inundation, in connection with the general improvement of the river. We unhesitatingly express our condemnation of all theories for the regulation of the Mississippi River and controlling its floods by the agency of "outlets;" it is our conviction that such a system would prove destructive to all the interests which are sought to be conserved and improved in connection with the treatment of the Mississippi River. We also state with thorough conviction and emphasis, that the belief entertained by some that the effect of long confinement of the Mississippi River by levees will be to produce a permanent elevation of the river bed, is a fallacious one, which is refuted by experience and contrary to all observation. We are familiar with all surveys that have been made of the Mississippi and with its present navigation, and declare that there is no evidence from either of these sources, or elsewhere, of progressive elevation of the bed of the Mississippi River from levees or other cause, except where caused by, and immediately below, outlets.

We submit the following information relating to expenditures upon the levees from the following sources:

By the United States Government, through the Mississippi River Commission, since 1882	$3,018,601 50
The Mississippi Levee Boards, since 1882	3,098,745 74
State and levee districts of Louisiana, since 1866	15,255,327 13
Of which since 1882 about	5,000,000 00
Arkansas	340,417 00

The above do not include expenditures which have been made by counties, corporations, and individuals in the several States. We estimate that a further expenditure of $10,000,000 by the General Government in co-operation with the riparian States, if promptly applied, will suffice to complete a system of levees that will prove enterely effective to restrain all future floods of the Mississippi River.

B. M. HARROD, C. E.
J. H. WILLARD, Capt. Engineers, U. S. A.
W. YOUNG, Capt. Engineers, U. S. A.
S. W. FERGUSON, C. E.
HENRY B. RICHARDSON, C. E.
WM. STARLING, C. E.
T. G. DABNEY, C. E.
H. S. DOUGLAS, C. E.
ARTHUR HIDER, C. E.
H. BOLIVAR THOMPSON, C. E.
H. ST. L. COPPEE, C. E.
JOHN SMYTH, C. E.
HENRY GOODRICH, C. E.
JOHN EWENS, C. E.
GEORGE M. HELM, C. E.
HORACE MARSHALL, C. E.

LEVEES.

RESOLUTION OF THE SOUTHERN PRESS ASSOCIATION.

CHARLESTON, S. C. *April* 30.

At the meeting of the Southern Press Association the following resolution was adopted:

Resolved, That it is the sense of the members of the Southern Press Association that the maintenance of an efficient system of levees on the Mississippi River is a matter of national concern, and that the Government should take the necessary steps to build and sustain such a system. Experience has shown that the people living along the banks of the river are unable to bear the burden of taxation necessary to support such a system, and it is not right that they should be required to do so. The Mississippi is essentially a national river; its floods should be restrained by the National Government.